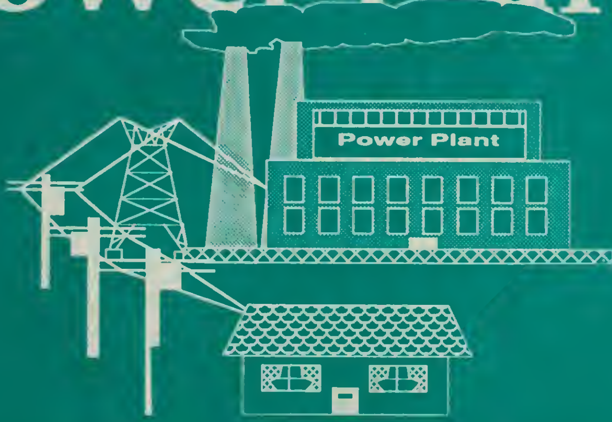
DOE/FE-0202P

Dinosaurs and Power Plants



~ Energy from the Past for the Future ~

Teacher's Lesson Plan and Activity Guide

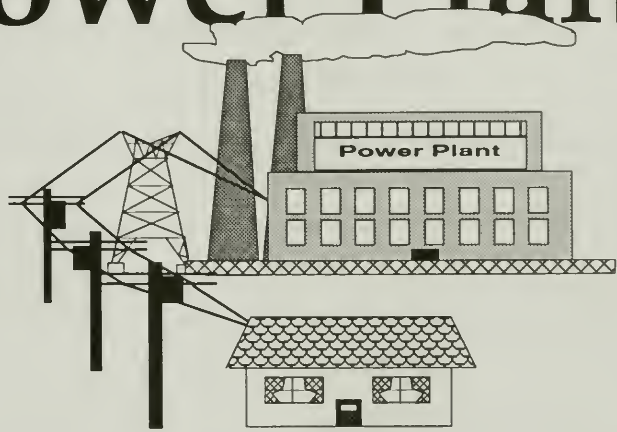
Office of Fossil Energy

U.S. Department of Energy

Rethink —
Reduce, Reuse, & Recycle

DOE/FE-0202P

Dinosaurs and Power Plants



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Rv. 1992

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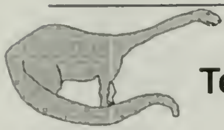


Teacher's Lesson Plan & Activity Guide

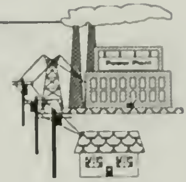
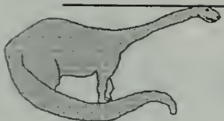
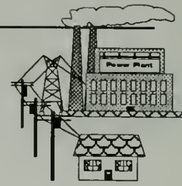


Table of Contents





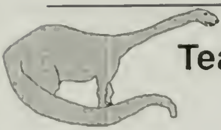
Short Titles and Abbreviations

1) The *Dinosaurs and Power Plants* booklet for students will be abbreviated as *"D&PP."*

2) The *D&PP Teacher's Lesson Plan and Activity Guide* (this document) will be referred to as the *"Teacher's Guide"* or as the *"Guide."*

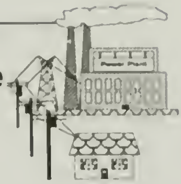
3) The *D&PP Teacher's Guide Supplement* of pictures, lists, and games will be called the *"Supplement."*

Dinosaurs and Power Plants



Teacher's Lesson Plan and Activity Guide

Fossil Energy Lesson Plan Series



Introduction

This *Teacher's Lesson Plan and Activity Guide* and its accompanying *Supplement* have been prepared to use with the U.S. Department of Energy's *Dinosaurs and Power Plants*, a publication designed for students in grades 5–8 about the history, detection, extraction, transportation, use, environmental problems/solutions, and future of fossil energy.

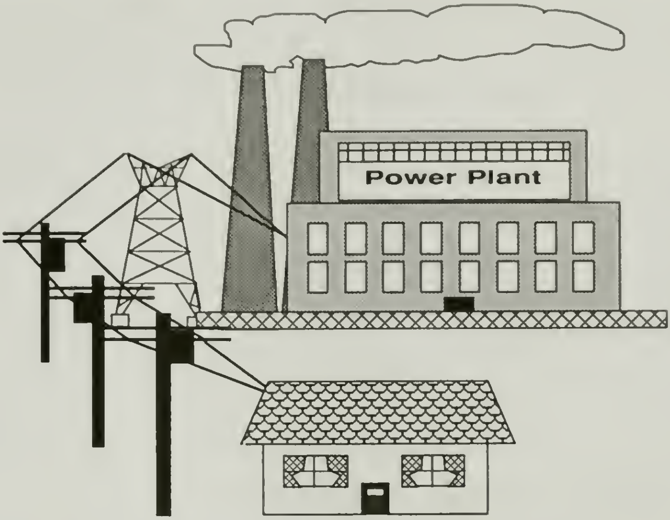
The study of energy science shows the close interrelationships of all creatures and phenomena. Therefore, attempts have been made to incorporate information in all three documents that involves history, geography, geology, biology, language studies, etc. Although the text of the *Teacher's Guide* closely follows *Dinosaurs and Power Plants*, some additional or more explicative information is included in the *Guide* for teachers to use in classroom discussions. The suggested lesson introduction methods and follow–up activities encourage the student to utilize or develop skills of leadership, deduction, communication, organization, socialization, observation, interpretation, and creativity.

Dinosaurs and Power Plants Teacher's Lesson Plan and Activity Guide

The *Teacher's Guide* is divided into five lessons: Fossil Fuels— 1) Importance and Formation; 2) Discoveries and Uses; 3) Detection, Extraction, and Transportation; 4) Environmental Problems/Solutions; and 5) Energy for the Future. Each lesson plan section is divided into four parts: Summary, Introduction Method, Key Questions and Answers, and Student Activities. The first page of each lesson plan shows a summary of the key questions to be covered, the lesson objectives, time allotment, and suggested materials to be used. The second (and sometimes third) page of each lesson plan suggests one or two methods for introducing the lesson topic. Key questions are answered by the italicized text seen within brackets on the right side of the page. The graphics (found on the left side of some pages in the *Teacher's Guide*) point out a picture or series of pictures that can be used with a particular portion of the lesson text. These small pictures can be found in an 8 1/2" x 11" format in the *Supplement*. Boxes are used in the *Guide* to provide additional information, offer suggestions for activities or graphics, or show needed materials. Student activities are offered at the end of each lesson plan. "Student Activity Options" can be performed in class at the time of the lesson. "Student Follow-up or Extension Options" can be done as homework, as classroom activities separate from the lesson, or as refresher activities in the days or months following the lesson series.

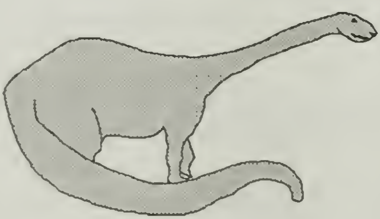
Dinosaurs & Power Plants Teacher's Guide Supplement

The *Teacher's Guide Supplement* contains 8 1/2" x 11" versions of the graphics in *Dinosaurs and Power Plants* and materials mentioned in the *Teacher's Guide*. The materials in the *Supplement* are presented in the five lesson plan format followed in the *Teacher's Guide*. Materials in the *Supplement* may be used for vu-graphs, bulletin boards, reproduction for individual student use, or any classroom activity.



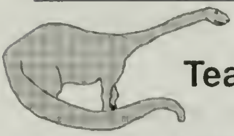
Teacher's Guide

Lesson One

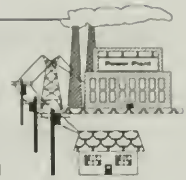


Fossil Fuels

Importance and Formation



Teacher's Lesson Plan & Activity Guide



Lesson 1: Fossil Fuels—Importance and Formation

Key Questions:

Why is fossil energy important in our lives? What are fossil fuels? How were fossil fuels formed?

> "Fossil energy" is a term for the group of energy resources formed from prehistoric plants and animals. "Fossil fuels" refer to the members of this group–coal, natural gas, and petroleum.

Objectives:

Students should be able to:

1. List at least three things that people and animals do that uses energy. *(D&PP page 1)*
2. Name three fossil fuels. *(D&PP page 1)*
3. Describe how fossil fuels were formed. *(D&PP page 1)*
4. Tell how much plant debris it took to form one foot of coal. *(D&PP page 1)*
5. List at least three things (more will be covered later) that run on energy products produced from fossil energy sources. *(D&PP page 1)*

Time Allotment:

30–45 minutes

Suggested Materials:

Dinosaurs and Power Plants ("*D&PP*"), pages 1 & 14
D&PP Teacher's Guide Supplement ("Supplement"), Lesson 1
- Drawing-"Using Energy: Dinosaur Jumping Rope"
- Drawing-"The Human Body: That Marvelous Machine"
- Drawing-"Gasoline...Is Used... to Power Cars"
- Drawing-"The Energy Needed to Power Our Lights..."
- Drawing-"How was Coal Formed?" (also *D&PP*, pg 1)
- Drawing-"Underground Geological Layers of the Earth"
- Word List
- Graphic-"Energy Equivalents" (also *D&PP*, pg 14)
- Copy of "Energy Uses" sheet for each student (need pencil or pen to answer questions)

Yardstick or Tape Measure (not included)

Introduction Method:

Purpose-

To introduce the student to the concept of energy as a common factor among all things

Activity-

Ask, "What do a dinosaur and you have in common?"

Using Energy

Dinosaur Jumping Rope

Supplement—Lesson 1 only

SUGGESTION: Give a short time for answers then show the picture of the "Using Energy: Dinosaur Jumping Rope" (found in the *D&PP Teacher's Guide Supplement*-Lesson 1) and ask "What does your body need to allow you to jump rope, run, or hit a ball?"

Answer, "*Energy*"

One Copy Per Student Needed of *Dinosaurs and Power Plants* and "Energy Uses Quiz"

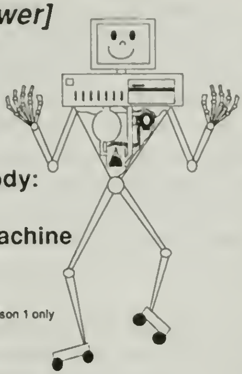
Hand out to each student a copy of *Dinosaurs and Power Plants* and of the "Energy Uses Quiz" (found in Lesson 1 of the *Supplement*). Have the class read page 1 of *Dinosaurs and Power Plants* and then complete the "Energy Uses Quiz." Follow these activities with a class discussion utilizing the Key Questions found in this *Teacher's Guide* on pages I-3 — I-6.

To begin finding out more about energy and how it is used, the class will read Page 1 of *Dinosaurs and Power Plants,* complete the "Energy Uses" quiz, and participate in a class discussion.

Dinosaurs and Power Plants

Key Question: **Why do you and every person, plant, and animal ever living on earth need energy?**

[and Answer]



The Human Body: That Marvelous Machine

Supplement—Lesson 1 only

[All living things, including dinosaurs, roses, butterflies, and you, have needed energy to move, eat, sleep, play, or even unfold a petal.

Your body is like a machine. You must have a fuel to run your engine because it is your engine (heart) that enables your levers (arms), wheels (feet), computer (brain), etc. to operate. Energy is the fuel you use to power your engine. People get energy from consuming many kinds of food. After we eat the food, our bodies digest and then burn it to produce energy.]

Key Question: **Why are fossil fuels important?**

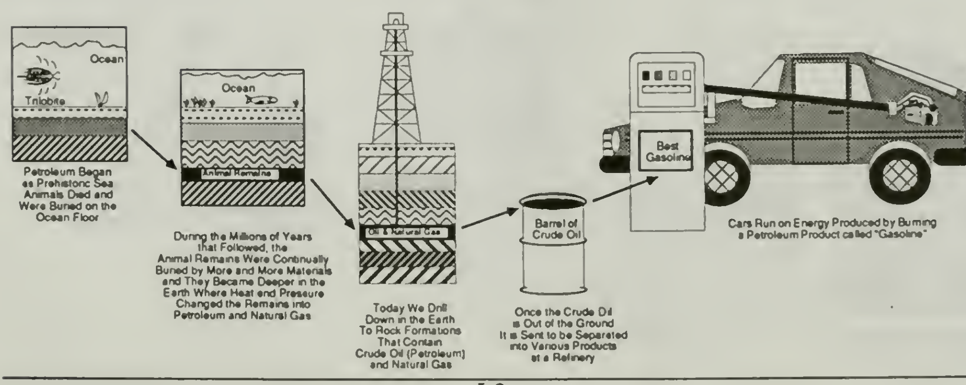
[Machines, such as the televisions, cars, and computers we take for granted in our daily lives, also need energy to run. Many times the energy used to power these things comes from "fossil fuels."

We burn natural gas, a fossil fuel, to heat our homes. We use gasoline, a product made from a liquid fossil fuel named "petroleum," to power our cars.

We get energy for our bodies when we eat food or for our cars when we burn fossil fuels.]

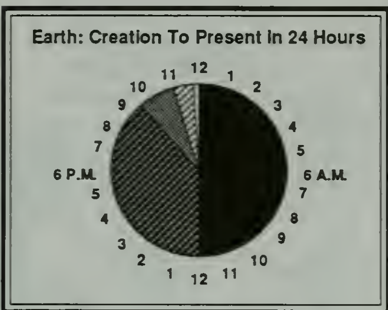
Gasoline, A Liquid Fossil Fuel, Is Used As Energy To Power Cars

Supplement—Lesson 1 only



Dinosaurs and Power Plants

Key Question: **What has a dinosaur got to do with the lights in your home?**



More Specific Information Shown On 8 1/2 x 11" Version In The *Supplement*

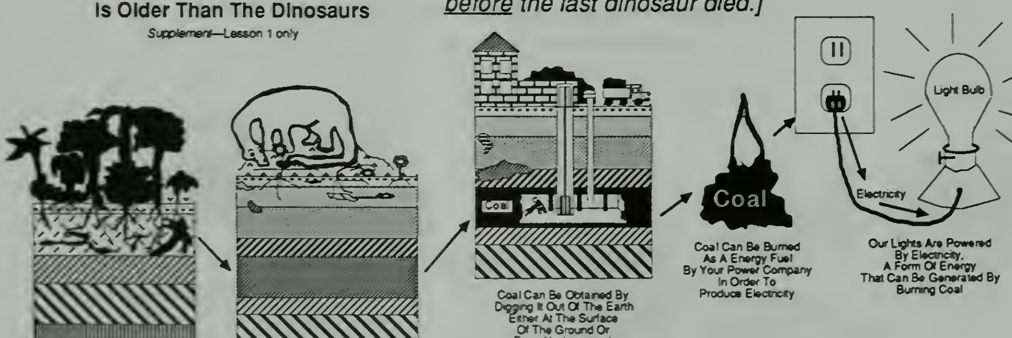
Supplement—Lesson 1 only

[*Energy again! The dinosaur ate and used food as fuel to produce the energy it needed to move, play, and even sleep. Our bodies need energy for the same reasons. However, we need energy also to power many things that we use in our everyday lives, such as the lights that help us see at night. The energy that makes your lights possible is called electricity. This electricity is produced mostly from fossil fuels that were formed from plants and animals that lived and died millions of years ago.*

Much of our electricity is produced by burning a fossil fuel rock called "coal." Coal is a very, very old type of fossil. It was formed from plants that flourished in the great swamp forests over 300 million years ago. The Earth's climate, soil, and atmosphere were favorable for thick plant growth. Many large areas of flat swampy land of perpetual summer existed where plants grew profusely, died, and fell into the shallow waters. These plants could be enormous. Plants, that today occasionally grow to three feet in tropical forests, grew to heights of 30-125 feet (impressively tall oak trees today are 100 feet tall). Some of the these plants had branches that grew directly out of their trunks making them look like 100 foot tall bottle brushes. Over millions of years these dead plants became coal. Anthracite coal can be over 100 million years <u>older</u> than a dinosaur fossil. Even the youngest member of the coal family, lignite, had been formed <u>before</u> the last dinosaur died.]

Most Coal That Is Used To Produce Electricity To Power Our Lights Is Older Than The Dinosaurs

Supplement—Lesson 1 only



Coal Began Forming From The Remains Of Plants That Died During Prehistoric Times Long Before The Dinosaurs Roamed The Earth

After The Plants Were Buried Deep In The Earth, Heat And Pressure Combined To Turn The Plant Remains Into A Fossil Fuel Rock Called "Coal"

Coal Can Be Obtained By Digging It Out Of The Earth Either At The Surface Of The Ground Or Deep Underground

Coal Can Be Burned As A Energy Fuel By Your Power Company In Order To Produce Electricity

Our Lights Are Powered By Electricity, A Form Of Energy That Can Be Generated By Burning Coal

Dinosaurs and Power Plants

Key Question: **What are fossil fuels?**

[The word "fossil" is defined as hardened remains of plant or animal life from some previous geological period that are preserved in the Earth's crust. Therefore, "fossil fuels" are materials that can be used today to produce energy (heat or power) that were created from plants and animals that lived millions of years ago. Like many fossils, these fossil fuels may be found deep in the layers of the Earth.]

Key Question: **Name three fossil fuels.**

[coal, natural gas, & petroleum]

Key Question: **Do you know which of the three states of matter (solid, liquid, or gas) each fossil fuel is?**

[Coal is a solid, petroleum is a liquid (although some may be very thick), and natural gas is a gas.]

> To prevent confusion, while we are studying fossil fuels we will use the word "gas" to refer to a substance that is readily dispersed throughout the atmosphere (i.e., the gaseous state of matter). The term "natural gas" will be used to refer to the fossil fuel. When we are discussing the petroleum product that powers most cars we will use the word "gasoline."

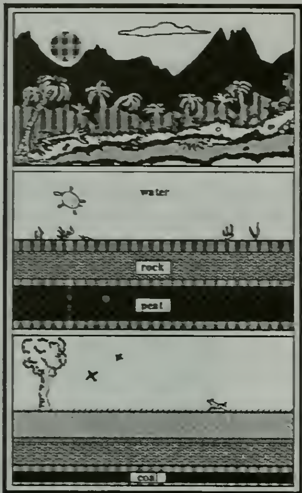
Key Question: **When and how were fossil fuels formed?**

a. When did fossil fuels begin forming?

[Some began forming from plants over 100 million years before the dinosaurs appeared.]

b. What were the original things that became fossil fuels?

[Coal was commonly formed from plant debris and natural gas and petroleum were formed from tiny organisms found in the prehistoric seas.]



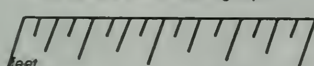
How Was Coal Formed?

D&PP—Page 1
Supplement—Lesson 1

Underground Geological Layers of the Earth

Supplement—Lesson 1 only

SUGGESTION: Show the difference in the amount of plant remains needed and amount of coal produced by marking the two lengths on the floor or wall with masking tape.



Yardstick or Tape Measure and Masking Tape Required

c. How were fossil fuels formed?

[When the plants died, they fell into the shallow swampy water and were buried over millions of years by increasing amounts of plants, mud, sand, water, and rock. Bacteria attacked the cellulose in the plant cell walls breaking up the large pieces of plant tissue. One of the products of this bacterial activity is methane gas, which sometimes can be seen bubbling up through the water and is called "swamp gas."

The pressure of the weight of the upper layers compacted the plant materials on the bottom into a dense substance called "peat." Peat forms relatively quickly in geological time, but slowly in human perception. A 2-3 inch layer of peat can form in about 100 years. Some of our modern swamps have peat layers over 30 feet in depth that represent relatively steady growth for 15,000 years. For instance, the Great Dismal Swamp in Virginia and North Carolina contains about 3/4 billion tons of peat today. It may take only a few thousand years to form peat, but it takes millions of years to form coal from this peat. As the peat is compacted by the weight of the increasing layers above, it is also buried deeper and exposed to heat deep in the Earth. During this final stage, temperature is the primary agent responsible for the change to coal. However, pressure can still play a big part also. For example, much of the anthracite coal in the U.S. was formed during the ancient formation of the Appalachian Mountains when Ancestral Africa collided with North America as the Earth concentrated its land masses into one continent called "Pangaea." The special combination of time, pressure, and heat changed these ancient plants and animals into the fossil fuels we use today.]

d. How much buried plant matter did it take to form a foot of coal?

[It took 10 feet of plant matter to make 1 foot of coal.]

e. Were there equal amounts of coal, natural gas, and petroleum formed?

[No, coal is much more common than natural gas or petroleum. The composition of the original materials, the amount and duration of pressure and heat, and the length of the formation period varied for each fossil fuel. The timing and the composition had to be just right for each one. These complex conditions evidently happened much more commonly in the case of coal than they did for natural gas or petroleum.]

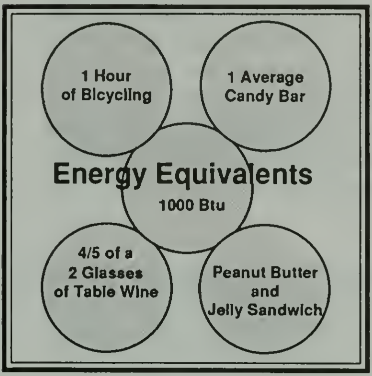
Key Question:

What keeps petroleum (a liquid) and natural gas (a gas) from escaping to the surface of the Earth?

[Petroleum and natural gas are often found under rock formations called "caprock" that are dense enough to trap the petroleum and natural gas and keep it from seeping to the surface. Some petroleum and natural gas have been found at the surface of the Earth and recorded by man. Marco Polo, an Italian explorer, wrote of seepages of oil in the Caspian Sea region. The "eternal fires" reported by Plutarch, a Greek historian, in the area of present day Iraq probably were natural gas seepages that had been ignited by lightning.]

Student Activity Options:

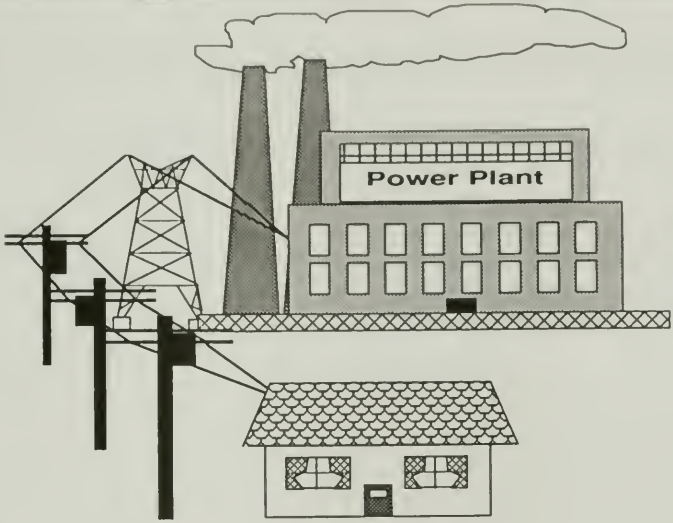
1. Read *D&PP*, page 1.
2. On the "Energy Uses Quiz" (found in the *Teacher's Guide Supplement*-Lesson 1) provided by the teacher, quickly LIST:
   a) the ways a dinosaur used energy,
      [finding food, running, swimming, etc.]
   b) the ways your body uses energy, and
      [playing baseball, holding a pencil, running, eating, watching TV, playing video games, etc. Even sitting or sleeping require energy.]
   c) three machines that use energy (electricity, coal, natural gas, or petroleum).
      [television, clock, furnance, bus, car, lights, computer, typewriter, intercom, air conditioner, fire or attendance bell, fan, cafeteria ovens & refrigerators, etc.].
3. Discuss the "Energy Equivalents" in *D&PP*, page 14, (also in the *Supplement*-Lesson 1).



D&PP—Page 14
Supplement—Lesson 1

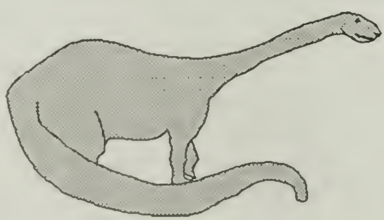
Student Follow-up or Extension Options:

1. Cut out pictures at home for a collage (to be finished at the end of the lesson series) of prehistoric animals and plants or pictures about coal, gas, or petroleum.
2. Read *D&PP*, pages 2 & 3, for the next lesson: Fossil Fuels–Discoveries & Uses.
3. Practice spelling words from the word list (found in the *Supplement*-Lesson 1) for this lesson or write a definition for each word or word group.
4. Designate a small square of space on a table top that can be left undusted for at least two weeks. Check the space after 24 hours to see what has collected. Check again each day for two weeks. Discuss 1) what has happened on your space and 2) how this small example can relate to soil layers outside. In two weeks, note how much material collected in your space. Then think how much could collect in a month, a year, 10 years, 50 years, 100 years,1000 years, one million years or in five billion years (the time that has passed since Earth formed).



Teacher's Guide

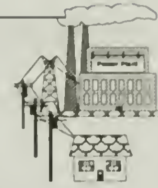
Lesson Two



Fossil Fuels

Discoveries and Uses

Teacher's Lesson Plan & Activity Guide



Lesson 2: Fossil Fuels—Discoveries and Uses

Key Questions:

Who first discovered fossil fuels? Where did they find them? How did we use U.S. fossil fuels in the past? How do we use fossil fuels today? How do we make our fossil fuel resources last longer?

Objectives:

Students should be able to:

1. List at least two people from the past who either used or reported sighting fossil fuels. *(D&PP page 3)*
2. List the dates and places that coal, natural gas, and petroleum were first used commercially in the United States. *(D&PP page 3)*
3. Name the reason why Americans needed both the natural gas and petroleum that came from the first commercial wells. *(D&PP page 3)*
4. List at least 10 things that are made from or run on fossil fuels or fossil fuel products. *(D&PP page 2)*
5. List three simple conservation methods that can be used to save energy. *(Teacher's Guide & Supplement-Both Lesson 2)*

Time Allotment:

30–45 minutes

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"), pages 2, 3, 13, & 15
Fossil Energy products for the Introduction (option)
D&PP Teacher's Guide Supplement ("Supplement"), Lesson 2
- Drawing-"The First Incandescent Lamp..."
- Drawings (7)-"First Uses of Fossil Energy"
- Drawing-"Today's Fossil Fuel Uses: Clock, Glasses, Telephone, School Bus, & Lawn Mower"
- Drawing-"Fossil Fuels and Electricity"
- Map-U.S. Strategic Petroleum Reserve Sites
- Word List
- "Fossil Energy Uses" List
- "Things Powered by Electricity..." List
- "Resource Conservation" List

Introduction Method 1:

Purpose-

To demonstrate to the student the close relationship between fossil energy and our daily lives.

Preparation-

If possible, turn off the classroom lights.

Activity-

Ask, "What do we need to make it possible to have lights in our room?" Turn the lights back on.

[Energy or electricity.]

If answer was "energy" ask, "In what form does this energy exist?"

[Electricity.]

"Where does electricity come from?"

*[It is produced in a power plant from fossil energy, nuclear energy, solar energy, etc. Over **half** of the electricity in the United States is produced from COAL, a fossil fuel rock.]*

Introduction Method 2:

Purpose-

To demonstrate to the student the close relationship between fossil energy and our daily lives.

Preparation-

Display a group of fossil energy related items.

Items that were made from or use fossil fuels are needed for this Introduction

SUGGESTION: See *D&PP Teacher's Guide Supplement*-Lesson 2 "Fossil Energy Uses List" for ideas of what items to use.

Activity-

Ask, "What do all these things have in common?"

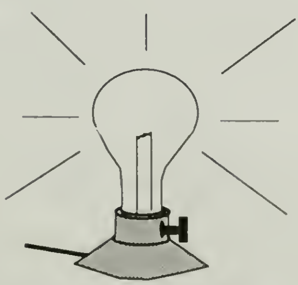
[They were all made using fossil fuels. Fossil fuels were either used to power the machinery needed to produce the products or to heat the materials used in manufacturing the product. Fossil fuels are also used as the base materials needed to produce plastic, paint, tape, etc. For instance, petroleum is required to make plastics and many types of medicines.]

Stop and Think Exercise

(Either Introduction)

How many of you can remember when video games or personal computers were unheard of? What about air conditioning? Can someone in your family remember when no one they knew had television? Can another person in your family remember when there were no electric refrigerators and they had to buy ice every day to keep the food from spoiling? Have you ever asked someone how they traveled before cars, buses, and planes existed?

[Electricity for homes was not common until almost 1900 in large cities. It was around that date that most of our inventions that use electricity were created. Before then, many things we have now, such as washing machines, sewing machines, etc., were hand powered. When electricity first began to be distributed to homes, it was then, as now, mostly generated by burning fossil fuels. Some of the inventions made possible by electricity produced by fossil fuels, inventors, and dates are: electric (incandescent) light bulb (Thomas Edison & Joseph Swan-1880), sewing machine (Isaac Singer–1889), vacuum cleaner (1901), refrigerator (1917), & dishwasher (1918).]



The First Incandescent Lamp (Electric Light Bulb) was Invented in 1880

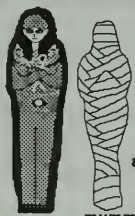
Dinosaurs and Power Plants

Key Question: **Do you know when and where fossil fuels were first discovered and used?**

[and Answer]

Alexander the Great burned oil to repel war elephants

D&PP—Page 3
Supplement—Lesson 2



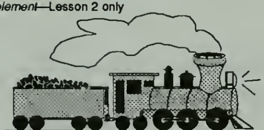
Egyptians used asphalt in the process that perserved human remains and created the ancient mummies seen now in museums

[Fossil fuels have been used since cavemen discovered how to burn peat (decayed plant materials that have not reached the coal stage) or coal for heat. Plutarch, a Greek historian, wrote about the "eternal fires" in the area of present day Iraq. These fires were probably caused by natural gas that was seeping through cracks in the ground and ignited by lightning. Alexander the Great burned petroleum to scare the war elephants of his enemies. The Egyptians used asphalt, a derivative of petroleum, to preserve human remains. The mummies seen in museums were produced using this process.]

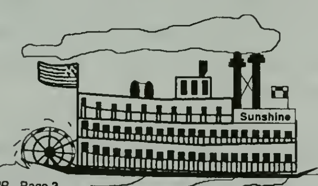
Key Question: **Can you tell me when fossil fuels were first utilized commercially in the United States?**

Coal *[Coal was discovered by explorers in 1673, but it was not mined commercially until the 1740's in Virginia. Before then, coal had been used by the Hopi Indians in the 1300's for heating and cooking. However, it was the Industrial Revolution that provided the real opportunity for coal to become the primary provider of energy for the Age of Machinery. Coal is still the number one fuel used to produce electricity. Today over half of the electricity in the United States is produced by burning coal in power plants. However, it was barely 100 years ago that burning coal became one of the leading ways to produce electricity so generation of electricity is a relatively new use for coal. Long after electricity was used for lighting, coal was still burned in home furnances for heating and in stoves for cooking. It was also used for powering various types of transportation machinery, such as trains and ships.]*

Supplement—Lesson 2 only



Coal powered many types of transportation



D&PP—Page 3
Supplement—Lesson 2

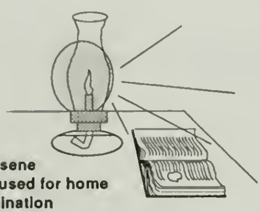
Natural Gas *[Natural gas was first sought commercially in 1821 when William A. Hart drilled a 27 foot deep well in Fredonia, NY, to get a larger flow of gas from a naturally occurring surface seepage. This natural gas was sent through* *<u>wooden</u>* *pipes to nearby homes for lighting. These wooden pipes allowed some gas to escape and was not an effective way to send natural gas long distances. It was more than 100 years before a efficient distribution system allowed natural gas to be*

Natural gas provided many towns with outdoor lighting

D&PP—Page 3
Supplement—Lesson 2

sent long distances to homes, factories, and businesses. As the people near these early wells could not use the large quantities of natural gas that was found and did not have good methods for containing the natural gas in the well, much of it was lost or wasted. For example, in towns with outdoor natural gas lighting, the lamps were left burning day and night.]

Petroleum



Kerosene was used for home illumination

D&PP—Page 3
Supplement—Lesson 2

[In 1859, Edwin L. Drake began the modern day petroleum industry in Titusville, Pennsylvania, when he drilled a 69 foot deep well and discovered crude oil. There was a shortage of whale oil that was used for lighting in some homes and for lubrication of machinery gears in some industries. The crude oil that was obtained from this well was used to form kerosene to use in lamps for illumination and to form grease for machinery.

> *"Petroleum" is used to refer to crude oil and all oil products. "Crude oil" is the actual unrefined petroleum that reaches the surface of the ground in a liquid state.*

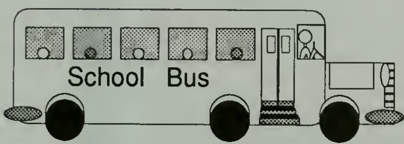
Before this time, a number of uses had been made of the asphalt, tar, etc. from the above ground seepages of petroleum in the U.S., but one of the most important historical uses was when the survivors of the DeSoto expedition utilized pitch to repair and make their ships watertight.]

Key Question:

How are fossil fuels used today?

[Fossil fuels touch every moment of our lives — when we wake up or sleep, when we eat, when we use our eyes to see, when we play or work, or when we are ill. For instance, petroleum not only can be refined into fuels, such as gasoline, to power engines; it can also be separated into petrochemicals from which plastics, medicines, paints, etc. can be made. The plastic of the alarm clock that wakes us up can come from petrochemicals. The farmer who raises our food may depend on fossil fuels for fertilizers to make his crop grow. When we read our eyeglass frames or lenses may be of plastic made from petroleum. When we listen to a cassette player or telephone we are using

equipment that is made from fossil fuels. The synthetic fibers that keep sheets on our bed from wrinkling are produced from fossil fuels. Photographic film for our cameras also is made from petroleum as are many medicines used when we are sick. When we go to work in an office much of the equipment, such as typewriter ribbons and computer disks, depend on fossil fuels for their composition. When we work in an industrial facility we may depend on coal to fuel the huge furnances or petroleum products to lubricate the gears of the machinery.



School buses need fossil fuel to run

We also depend on petroleum products for transportation when we ride a bus or other vehicle to school. Even the school we go to probably was built using fossil fuels, such as coal to manufacture the bricks and petroleum for the tarring and waterproofing the roof. The heat in our homes or schools may come from natural gas. Clothes dryers or water heaters may also use natural gas to heat the air or water. Even the lawnmower runs on gasoline or electricity that both come from fossil fuels.

Lawn mowers use energy to turn the blade that cuts the grass

Most of our lives depend upon fossil fuels — not just for the energy, such as the electricity we take for granted, but many times for jobs, such as steel making or building construction or bus driving, and sometimes even for the manufacturing of the clothes we wear on our backs.]

Key Question:

How is electricity produced by fossil fuels?

> Can you find out what each of these people did that helped lead to our present system for generation of electricity?
> *(Refer to each name or to "electricity" in an encyclopedia.)*

[Many inventors paved the way to modern day electric generation. Some of these people, the date of their work, and their country are: Thales (600 b.c. Greece), Benjamin Franklin (1752 USA), Andre Ampere (1820 France), Michael Faraday (1831 England), Zenobe Gramme (1870 Belgium), Thomas Edison (1880 USA), George Westinghouse (1887 USA), and Nikola Telsa (1890 USA).

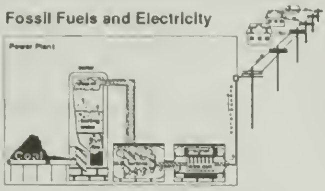
Thomas Edison opened the Pearl Street steam electric Station on September 4, 1882, in New York City. It was the first commercial power station in the U.S. for incandescent lighting. By October of that year, the station was providing 59 customers in a square mile area with electricity for lighting 1284 incandescent

Who can find out how much we pay today per kilowatt hour for electricity? *(Check your home electrical bill or call your local electrical company.)*

lamps (electric lights) at about 25 cents per kilowatt hour. The station had a total capacity of 600 kilowatts. (Today's fossil fuel power plant may have a capacity of over one million kilowatts.)

Electricity was first produced in two kinds of power plants: Fossil fuel steam electric plants and hydroelectric plants (the first hydroelectric plant opened on the Fox River in Appleton, Wisconsin, 26 days after the Pearl Street steam electric plant opened in New York).

Fossil Fuels and Electricity



Burning Coal to Generate Electricity

D&PP—Page 3
Supplement—Lesson 2

SUGGESTION: Show the drawing "Fossil Fuels and Electricity" found in the *Supplement*-Lesson 2 or refer to the picture with the same title on page 2 in *D&PP*. Trace each step on the picture.

Electricity today can be produced by your utility (electric) company at a power plant by burning a fuel, such as coal, to heat a large quantity of water in a giant closed tub (sometimes 15 stories tall) called a "boiler." As the water boils, it produces steam (like boiling water in a covered pan on your stove). The steam is collected at the top of the boiler and sent through pipes to another enclosure called a "turbine" that has large blades (somewhat like propeller blades on an airplane).

The steam rushes in causing these blades — and the shaft the blades are mounted on — to turn. Since this turbine uses steam to turn the blades, it is called a "steam turbine." The rotating shaft in the turbine also extends into a last box called a "generator" where it turns a wire coil attached to it.

The generator also contains a magnet. The wire coil is inside this magnet. The electrical current that is generated by moving the wire coil inside the magnet is collected by the wire coil and sent out of the power plant as electricity to your school or home.

The electricity is carried by wires usually strung from pole to pole (sometimes referred to as "telephone poles") to your home.]

Dinosaurs and Power Plants

Key Question: **Will our fossil fuel resources last forever?**

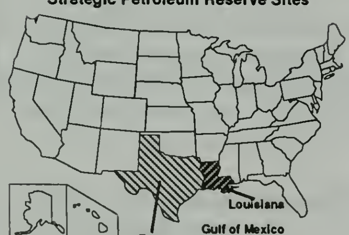
[Fossil fuels we use today began to form millions of years ago. Due to several factors, such as the length of time required to form these fuels, increasing population, and wasteful usage, we are using fossil fuels faster than they are being formed. However, we still have enough coal, petroleum and natural gas on earth to last many years. In fact, within the U.S. boundaries, we have 1/4 of the world's supply of coal. That amount is enough to last, using today's consumption rates, approximately 300 years.

However, we are not so lucky when it comes to petroleum and natural gas. They are less plentiful, more elusive to find, and harder to get out of the ground. The United States uses each day an average of 16 million barrels of petroleum. We use more oil than we produce within our borders and have to buy oil from other countries. We have crude oil left in the U.S., but much of it is difficult or very expensive to get out of the ground.

The U.S. Department of Energy is funding research about how to get more oil out of these reservoirs at lower costs. The next lesson will cover some of these ways.

As of yet, we are still having to depend on foreign countries for much of our oil. The oil embargo of 1973–1974 when many Arab nations cut off the oil flowing into the U.S. and created long waiting lines at our gas stations dramatically demonstrated the need for a national oil stockpile. In the aftermath of the oil crisis, America established the Strategic Petroleum Reserve, an emergency supply of crude oil stored in underground salt dome caverns along the Gulf Coast in Louisiana and Texas. It is our national "insurance policy" in case of oil disruption emergencies and is the largest stockpile of crude oil in the world.]

Strategic Petroleum Reserve Sites



Supplement—Lesson 2 only

SUGGESTION: Show the location of the Gulf of Mexico, Louisiana, and Texas on a classroom map of the United States or show the map found in the *Supplement*-Lesson 2.

Key Question:

If we have this stockpile of oil and have an abundant supply of coal, why do we need to make our fossil fuel resources last longer?

[There are several reasons to help conserve our fossil energy resources, including:

1) *The* ***costs for heating, lighting, cooling, electricity, cooking, and fossil fuel products can consume a large portion of a household budget.*** *The money we save by not wasting energy and fossil fuel products is money we can use in other ways.*
2) *The* ***more*** *fossil fuel products* ***we use and throw away,*** *such as plastic cups, disposable diapers, computer disks,* ***the more solid waste we must bury or burn.***
3) ***Your parents may have plenty of fossil fuels*** *to use,* ***but what about*** *later when* ***you*** *(age 10 now) are 25 years old? (15 years from now)* ***Or your children*** *when they are 25? (having a child at age 25–only 40 years away)* ***Or your children's children?*** *(just 65 years in the future)*

We have to become more responsible in our use of all of our resources. We have to learn to think beyond today to tomorrow when we will have to face the consequences of what we do today. We have to think of the world we will live in tomorrow or we will leave for others. Even now, we are facing challenges caused by previous years of careless living. Without careful planning and consideration, we may have to face even more severe future challenges to the environment, our health, and the cost of living.]

Key Question:

How can we make our fossil fuel resources last longer?

Resource Conservation

Resource Conservation Methods List Available in the Supplement—Lesson 2

[There are simple actions, called "conservation" methods, we can take to save energy and natural resources.

1) *Turn off lights when you leave the room and turn off the television or radio whenever you go to do something else.*
2) *Decide what you want from the refrigerator* ***before*** *opening the door. Do not hold the door open for a long time and let the cold air out. Check to make sure you shut the door completely.*

Resource Conservation (cont'd)

3) Whenever possible walk or ride your bicycle instead of taking a car.

4) Test your windows and doors to see if air leaks in or out. (See "Student Activity Options #2: Making a Draft Detector:) If it does, apply weatherstripping to those with air leaks to seal the heating or air conditioning in and reduce your utility bill.

5) Wear warmer or cooler clothing that allows you to set your thermostat lower in the winter (keep your home cooler) and higher in the summer (keep your home warmer).

6) Take short showers rather than baths to save on hot water (and wastewater that will have to be cleaned at the local water treatment facility).

7) Use as few disposable items as possible. The more items we throw away, the more land we will have to use for solid waste disposal. And the more it will cost you for collection and disposal of these waste items.

8) Recycle as many reusable items as possible. Recycling helps us reuse the resource that originally created the product rather than having to use more raw resources to make new products. For instance, recycling newspapers will reduce the number of trees required to make paper.

9) There are many other conservation methods that will help save our resources. Check with your local power company or recycling center for additional information.

Student Activity Options:

1. Half of the class will list things that are made from fossil fuels and half of the class will list things that run on fossil fuels. Determine which group produces the longest list.

> Suggestion: See the "Fossil Energy Uses" and the "Things that are Powered by Electricity..." lists found in the *Supplement.*-Lesson 2.

2. Check the classroom for heating and cooling loss by producing a draft detector and checking the windows and doors in your room.

> **Making a Draft Detector**
>
> Cut out a piece of clear plastic food wrap about five inches by 10 inches. Tape the five inch end to a short stick so the long end hangs freely. For the stick, you could use a pencil or a ruler.
>
> Test the draft detector by blowing very slightly on the plastic hanging down. Notice that even when you blow ever so lightly, the plastic moves and shows the movement of the air. Then hold the draft detector close to where the window or door meets its frame. Determine whether there are drafts stealing the heat or air conditioning from your room by watching to see if the plastic moves.

Check the Conservation Methods list to see what can be done to prevent energy from being lost through your window and doors.

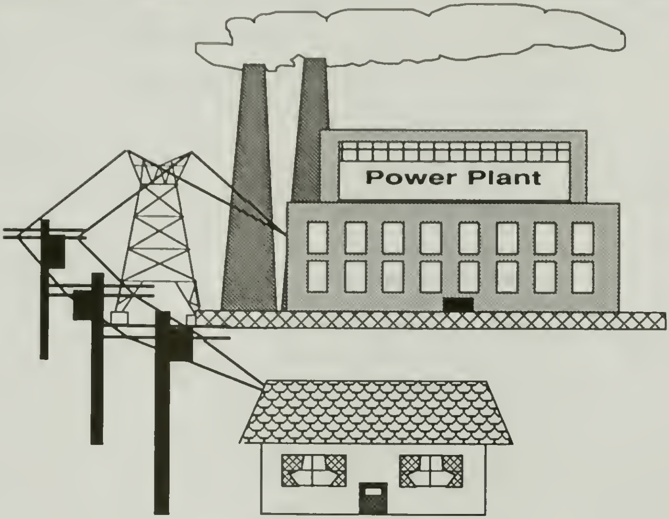
Student Follow-up or Extension Options:

1. Read *D&PP*, pages 4–7 and 11, for the next lesson: Fossil Fuels–Detection, Extraction, and Transportation.
2. Write a letter to the local power company for information on what fossil fuels it uses to generate electricity and on how much electricity various applicances and audio equipment use per hour. (See "Things to Do" in *D&PP*, page 13)

continued...

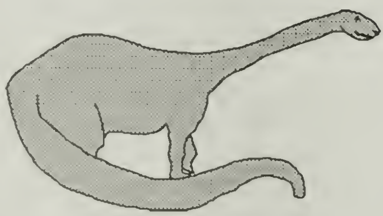
Student Follow-up or Extension Options (cont'd):

3. Write a story about a day in the life of a pioneer student without electricity, central heat, cars, video games, television, radio, etc. (See "Things to Do" on *D&PP*, page 13).
4. Give a report on how much it costs to run the family vehicle for one year (See "Things to Do" in *D&PP*, page 13).
5. Clip pictures at home (for the collage) of things that are run on fossil fuels (e.g., car) or electricity made by burning fossil fuels (e.g., refrigerator) or things that are made from fossil fuels (e.g., plastics, paint, medicines, adhesives, etc.).
6. Each time you use something that uses electricity or a fossil fuel, write down its name (e.g., TV, radio, car, hot water [heater], lights, refrigerator, toaster, microwave, garage opener, telephone, escalator, bus, computer, etc.) and the type of fossil fuel.
7. Ask a resource speaker from the local power company to discuss energy resources, uses, and conservation.
8. Write the U.S. Department of Energy Office of Conservation and Renewable Energy for information on ways to conserve energy. (See "For More Information" in *Dinosaurs and Power Plants*, page 15).
9. Write a report on automated inventions (no later than 1930) that were made possible by electricity produced from fossil fuels and on the inventors of these machines.
10. Talk to relatives and older friends to find out what people did before electric washing machines, refrigerators, televisions, radios, typewriters, computers, fans, air conditioners, elevators (how tall were buildings before there were elevators?), lights, etc. were available to the average person. What did they do without buses, cars, trucks, and airplanes that are powered by fossil fuels?
11. Practice spelling words from the word list for this lesson (found in the *Supplement*-Lesson 2) or write a definition for each word or word group.
12. Determine how much the lights in your classroom/school cost per year (use the exercise sheet found in the *Supplement*-Lesson 2).



Teacher's Guide

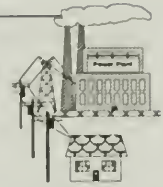
Lesson Three



Fossil Fuels

Detection, Extraction, and Transportation

Teacher's Lesson Plan & Activity Guide



Lesson 3: Fossil Fuels—Detection, Extraction, and Transportation

Key Questions:

Where do we find fossil fuels? How do we get them out of the ground? How do we get them to the people who need them?

Objectives:

Students should be able to:

1. Name, describe, and give a general mining location for each of the four kinds of coal. *(D&PP page 4)*
2. Name two types of coal mining. *(D&PP page 4)*
3. Name at least two places "unconventional" gas deposits may be found. *(D&PP page 5)*
4. Tell why we need Enhanced Oil Recovery (EOR) and describe one EOR technique. *(D&PP page 6)*
5. List one way each to transport coal, natural gas, and petroleum. *(D&PP page 11)*

Time Allotment:

One or two 30–45 minute lessons

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"), pages 4–7, 11–13, 15 & 16

Small aquarium or container with glass sides, sand, one quarter, 4 small wrapped candies, some cola sealed in a sandwich bag, and six pennies

D&PP Teacher's Guide Supplement ("Supplement"), Lesson 3

- Drawings (3)-"Finding Natural Gas"
- Photo-"Scientists with Methane Hydrate Crystals"
- Drawings (4)-"Coal Mining"
- Photo-"Coal Mining Equipment"
- Drawing-"Drilling for New Oil"
- Photo-"Workers Operating a Drilling Rig"
- Drawing-"Petroleum Formations"
- Drawings (3)-"Recovery of Oil from Deep in the Earth"
- Drawing-"Petroleum Pumping Unit"
- Photo-"Pumping Units in an Oil Field"
- Drawing-"Offshore Drilling Rig"
- Drawing-"Transportation" (see D&PP pg 16 for <u>quiz</u>)
- Maps (3)-"Fossil Fuel Producing States"
- Word List
- Copy of "Coal Facts and Quiz" for each student (need a pencil or pen to fill in answers)

Introduction Method:

Purpose-

To give the student a better understanding of the complexities of finding and producing fossil fuels, this Introduction will acquaint the student with the challenges that geologists and miners/drillers face trying to find and extract resources that are underground.

Preparation-

Small aquarium or container with glass sides, sand, one quarter ($.25), 4 small wrapped candies, cola sealed in a sandwich bag, & 6 pennies needed for this exercise

Before class, fill a small aquarium or container with glass sides about 3/4 full of sand. Bury in different locations in the sand, 1) one quarter, 2) a short row of four small wrapped candies, and 3) a sandwich bag partially filled with cola and sealed. Make sure that none of the items can be seen from any side of the aquarium. Keep the six pennies on hand for use during the demonstration.

Activity-

Gather the students around the aquarium.
Ask them what is in the aquarium. The answer will probably be "just sand." Tell them that there are actually some "resources" under the sand.

Ask how they would tell what the "resources" are, where they are, and how would they get the them out. If someone suggests digging up or pouring out all the sand, explain that this exercise is designed to imitate on a small scale the process of finding and extracting fossil fuels. The sand in the aquarium is like a cross section of the Earth.

It is difficult to locate fossil energy resources that are buried deep in the Earth. It is made more difficult when the land to be explored has homes, industries, schools, or wildlife sanctuaries located on the surface. (Place the pennies around the surface to represent these situations.)

Ask the students how they would feel if their home or school was represented by one of the pennies that is near or on an area of potential "resource" mining or drilling. Would careful planning be important?

If lesson 3 is split into 2 days, allow the students to think of solutions overnight and present their ideas as the Introduction to the second day of the lesson.

List on the chalkboard the ways students decide these underground "resources" can be found and removed. Allow the students with ideas voted to be the best to extract and keep the "resources." Note any problems that occur on the surface of the sand (e.g., landslides around the "houses" or other pennies).

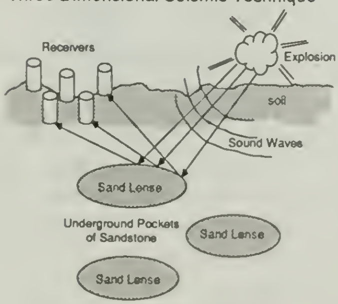
Key Question: Do you know how today's "explorers" find fossil fuels?

[and Answer] *[Geologists are explorers, but they are historians also. They study the history of the Earth to be able to determine today's structure of the Earth's crust, the composition of the earth's interior, individual rock types, forms of life found as fossils, etc. By studying the geology of a region, they can determine general areas that are likely to have coal, sandstone, limestone, etc. formations. It is then up to exploration teams to go to the area, pinpoint the location, and drill or mine the coal, natural gas, or petroleum. Using the current technology, we still sometimes explore locations that look very promising only to spend money drilling a "dry well" (no oil or gas found). Therefore, researchers throughout our country are working to find more accurate, quicker ways that cost less to find our underground (or undersea) resources.*

Natural gas and petroleum are found by bouncing sound waves off of underground land formations and measuring the time it takes for the sound to travel from the sound source (usually an explosion set off by geologists looking for natural gas) to mechanical receivers that record the data. Each formation has certain characteristics that geologists look for in the data that is recorded by the receivers. This technique allows us to "see" the formation below the surface.

There are three methods used for detecting natural gas located within sandstone formations. These three are: Three Dimensional (3D) Seismic , Vertical Seismic Profiling, and Cross–bore Seismic.

Three Dimensional Seismic Technique



Finding Natural Gas
(1 of 3 Examples)

D&PP—Page 5
Supplement—Lesson 3

"Seismic"is defined as of or having to do with earthquakes or man–made ground tremors.

SUGGESTION: To demonstrate the differences in the techniques, show the three pictures of "Finding Natural Gas" on *D&PP*, page 5, or in the *Teacher's Guide Supplement*-Lesson 3.

Key Question: **How are fossil fuels obtained from the Earth?**

Coal

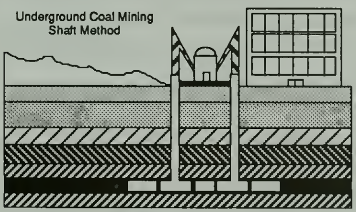
[Coal was initially obtained from the surface or near surface where it was easily mined. Today where coal is found somewhat near the surface and the overlying layers of materials can removed at a reasonable cost, it is mined using surface mining techniques. Where coal lies in deeper layers of the Earth, it is reached through underground mining. There are different kinds of underground mines, such as drift, slope and shaft. The type of mine depends on where the coal is located.

Surface Mining

Underground Mining

SUGGESTION: Show types of coal mines by using the four "Coal Mining" pictures from the *Supplement*-Lesson 3 or referring to pictures on page 4 of *D&PP*.

All types of underground mines use one of three methods of digging out the coal. These methods include room–and–pillar, long wall, and bord–and–pillar techniques. The room–and–pillar method is used frequently in mines in the United States.



Coal Mining
(1of 4 Examples)

D&PP—Page 4
Supplement—Lesson 3

Using this technique, the coal is mined or carved out and pillars (like huge columns) of coal are left to support the walls and ceilings of the passageways. Room–and–pillar does leave a substantial portion of the coal unmined. However, where possible some of the pillars are mined also.

In each underground mine, large holes (shafts) are also cut from the surface to the underground mining area for air and transportation for workers and for hauling coal out of the mine. Coal can be carried out of a mine on a conveyer belt or in small railcars on a track.

A type of coal mining equipment called a "longwall mining machine" can be shown by using the photograph by the same name in the *Supplement*-Lesson 3.

There are ***four types (or "ranks") of coal*** *mined today:* ***Anthracite, bituminous, subbituminous, and lignite.*** *Anthracite is the hardest and gives off much heat when burned but little smoke. Unfortunately, there is little anthracite in the world. The other ranks of coal are softer , give out less heat , and increasingly more smoke. Bituminous coal is the next rank, followed by subbituminous coal. Lignite, the youngest coal, is at the lowest end of the coal family and emits the most smoke. In some pieces of lignite, you can even see the texture of the original plants (as in other fossils you may have seen) that formed the coal.]*

Can you find on a map the regions or states where the four ranks of coal are found in the United States? See *D&PP* page 4 for information.

Natural Gas

[Natural gas has collected in a variety of locations and conditions. It is not only found in pockets by itself or with petroleum, but may also be present in

Unconventional Deposits

"unconventional" gas deposits. These deposits include 1) shale formations, 2) sandstone beds (tight sand lenses), 3) coal seams, and 4) deep, salt water aquifers (underground pools of water).

These underground sources are more difficult and more expensive to produce than the conventional deposits (where natural gas is found by itself or with petroleum), but they hold the potential for vastly increasing the nation's available gas supply and, therefore, are being studied as potentially valuable resources.

Tight Sand Lenses

Tight sand lenses (the type of formation found by the seismic reading technology discussed earlier) are called "tight" because the holes that hold the natural gas in the sandstone are very small. It is very hard for the natural gas to flow through these tiny spaces. To get the gas out, drillers must first crack the dense rock structure to create ribbon–thin passageways through which the gas can flow.

Methane Hydrates

Research is also continuing on possible ways to extract natural gas from other types of deposits. The U.S. Department of Energy is funding studies to determine the causes of a type of gas, called "methane hydrate." Methane hydrate is a cage of ice in which molecules of natural gas are trapped. It is found in deep ocean beds or in cold areas of the world, such as the North Slope of Alaska or Siberia in the U.S.S.R. It can also be found in deep waters of the Gulf of Mexico.

SUGGESTION: Show the photograph found in the *Supplement*-Lesson 3 of two scientists holding pieces of methane hydrate

Scientists with Methane Hydrate Crystals

(This drawing is only a representation of the photograph)

Supplement—Lesson 3 only

There are even theories about additional formations where natural gas may occur. For instance, the federal government is funding research on the theory that there are pockets of natural gas very deep in the ground that were formed at the time of the creation of the Earth rather than later when animals began to swim the seas.]

Petroleum

If the Lesson is to be divided into two parts, begin the second session at this point.

[Petroleum can also be difficult to get out of the ground. It can be as thin as kerosene (like nail polish remover) or as thick as tar.

Contrary to popular belief, petroleum in underground reservoirs does not act like soda in a bottle where you put in a straw and the soda comes right up.

(A "reservoir" is a place on the surface or below ground — this is the case for petroleum — where a substance is collected and stored. There may be an above ground reservoir near you. Sometimes cities set aside a man–made lake of water as a source of drinking water.)

SUGGESTION: For the following discussion, show the rotary drilling rig from "Drilling for New Oil" found in Lesson 3 of the *Supplement* or refer to page 7 of *D&PP.*

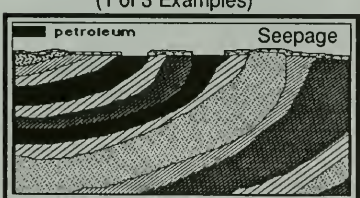
Rotary Drilling Rig

D&PP—Page 7
Supplement—Lesson 3

Drilling Equipment

Petroleum reservoirs are tapped by drilling down through the overlying layers of dirt, rock, etc. until the reservoir is found and the petroleum comes to the surface. Most drillers looking for oil use a rotary drilling rig to dig from the surface down to the petroleum reservoir. A tall support shaped like an upside down ice cream cone holds a strong shaft that has a "drill bit" with "teeth" that rotate and chew through the rock. Another part of the rotary drilling rig is a "mud pump" at the surface that assists in pulling mud and debris out of the hole as it is being dug.

Petroleum Formation
(1 of 3 Examples)



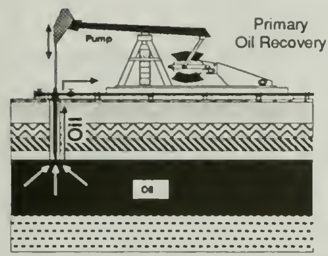
D&PP—Page 7
Supplement—Lesson 3

SUGGESTION: To show underground formations where petroleum may be found, show "Petroleum Formations" from the *Supplement*-Lesson 3 or refer to *D&PP*, page 7.

Petroleum Formations

During the millions of years that petroleum took to form, the Earth has changed many times. Therefore, the formations in which petroleum may be found vary greatly. In the past, petroleum could be found seeping to the surface from where it had formed underground (<u>seepage</u> formation).

Today, it is found mainly underground and in strikingly different places. One reservoir may be found where the layers of the Earth have buckled and formed small waves (anticline formation). Another reservoir may be at the edge of a fault where the layers of rock, dirt, etc. underground have split and one side of the split is trying to ride over the other (fault formation). The types of materials on top of the petroleum reservoir may also vary tremendously. Many times the overlying layers are very dense or hard and may wear out several drill bits before the reservoir is reached.



Recovery of Oil from Deep in the Earth
(1 0f 3 Examples)

D&PP—Page 6
Supplement—Lesson 3

SUGGESTION: To show methods of extracting crude oil, use the three "Recovery of Oil" pictures found in the *Supplement*-Lesson 3 or on *D&PP*, page 6, with the following text.

Primary Oil Recovery

As a petroleum well first comes in (when the reservoir is first tapped and some petroleum comes forth), a portion of the crude oil — and possibly some natural gas — will be expelled from the rock formation due to natural pressure. After the initial pressure is depleted, a mechanical pump is used to pull the oil out of the ground. The movement of the pump may look like the head of a rocking horse bobbing up and down. This first method is called "primary" recovery.

Oil Well Pumping Unit

D&PP—Page 7
Supplement—Lesson 3

SUGGESTION: See page 7 of *D&PP* for an illustration or show "Petroleum Pumping Unit" or "Pumping Units in an Oil Field" pictures found in the *Supplement*-Lesson 3.

However, much of the petroleum left now in the U.S. cannot be forced up even with a pump at the surface. As a result, we have to use other methods to get the crude oil out of the ground.

Secondary Oil Recovery

Another technique that can be tried is "waterflooding" where water is forced down a pipe to the petroleum reservoir to displace and force the crude oil to the surface. This is called "secondary" recovery. However, this method will only produce a little more crude oil from the reservoir than primary recovery did.

Enhanced Oil Recovery

Therefore, we must devise even more advanced ways, called "enhanced oil recovery," of getting oil out of the ground. These advanced methods must also keep costs low so that this crude oil will not exceed the current market price. If the costs do exceed the price consumers are currently paying, this crude oil becomes too expensive to recover.

Have you ever noticed how chocolate goes from a solid state to a thick liquid to a thin, runny liquid as it gets warm? It will even melt in your hand!

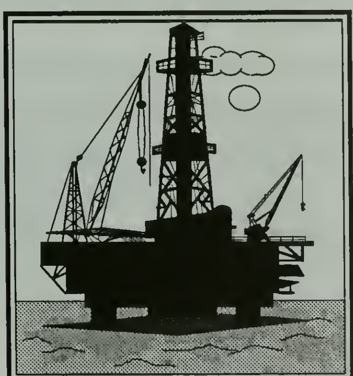
One enhanced oil recovery (EOR) method utilizes steam to heat the petroleum where it is trapped underground. The steam is pumped down through a pipe and left for a period of time. As the petroleum heats up, it thins. When the petroleum thins it becomes much easier to pump from the ground. This enhanced oil recovery method is nicknamed "huff and puff."

MEOR

Another EOR method called "microbial enhanced oil recovery" or MEOR sends living bacteria down a pipe to one side of the petroleum reservoir. These bacteria or "microbes" are fed a substance, such as molasses, that causes them to "burp" gas that pushes the petroleum to the other side of the reservoir and up a pipe to the surface.]

Key Question:

Is petroleum only found on dry land?

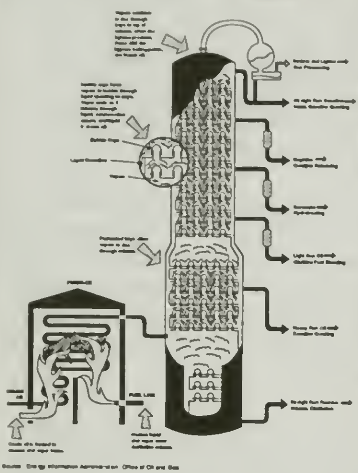


Offshore Drilling Rig

D&PP—Page 7
Supplement—Lesson 3

[No, petroleum is also found and extracted from the waters surrounding the United States and other countries. The first "offshore drilling" in the United States was in 1897 off a pier near Santa Barbara, California. Offshore drilling methods and equipment are similar to those on land except the workers have to build a man–made island or platform over the water to support the drilling rig and other equipment. In addition, the platform must also have space for sleeping and eating as the well may be too far out for the workers to travel to it each day. Many offshore platforms also have landing platforms for helicopters to deliver workers, equipment, and supplies.]

Key Question: What happens to crude oil once we get it out of the ground?



Fractionating Tower

Petroleum Refining by Distillation

Supplement—Lesson 3 only

[The crude oil is delivered by tanker truck, ship, or pipeline to a refinery where it is separated into its various basic components. This is called "refining." Petroleum can be many things besides just gasoline and lubricating oils for our cars.

One way crude oil can be separated or "distilled" into its various components or "fractions" is by heating it. Distillation can occur in a fractionating tower. Each one of the various components has a different point at which it turns into a gas. At the point it becomes a gas, it can be drawn off of the original crude oil. The new product is then condensed back into a liquid and stored separately.

(This is like boiling water on your stove. When the water reaches its boiling point the water turns to steam and rises. The steam can then be drawn off.)

After the petroleum products leave the refinery, they are delivered to users for either more processing or for their specific use as a fuel, lubricant, or petro-chemical (to create plastic, adhesive, insulation, medicine, detergent, or textiles.]

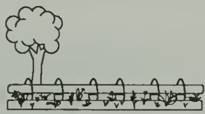
Key Question: How do Fossil Fuels get to the user?

Trucks

D&PP—Page 16
Supplement—Lesson 3

[Many fossil fuel mining or drilling sites are remote from the location of the ultimate user. Therefore, it is necessary to have an extensive transportation and storage system to get the fossil fuel to the consumer. Fossil fuels may be transported by land or sea. Because it is a liquid, petroleum is generally easier and cheaper to transport than is coal, a heavy solid. Natural gas is even less expensive to transport than is petroleum.

Petroleum & Natural Gas

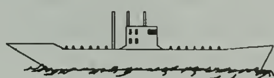


Pipeline
D&PP—Page 16
Supplement—Lesson 3

One of the least costly and most convenient methods of transportation is by underground pipeline. The first major cross–country oil pipeline of 110 miles was laid in Pennsylvania starting at the site of the first well in Titusville. The pipeline system for natural gas is even more extensive than for petroleum. In fact, the U.S. network of pipelines for natural gas, if connected end to end, would stretch to the moon and back twice.

Barge
D&PP—Page 16
Supplement—Lesson 3

Petroleum can also be shipped by land in barrels on flatbed trucks or on rivers in barges. Tank trucks and railroad tank cars are really just large barrels designed to carry many, many barrels of crude oil or petroleum products. Oceangoing ships or "supertankers" have divided compartments where vast quantities of crude oil can be stored for delivery overseas.



Supertanker
D&PP—Page 16
Supplement—Lesson 3

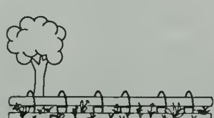
Natural gas may also be shipped by tanker truck or railroad tanker. It can also be cooled to 100 degrees or more below zero (F) where it changes to a liquid that can be carried in huge insulated ships.

Railroad
D&PP—Page 16
Supplement—Lesson 3

The transportation and distribution system also has to provide for storage of petroleum that arrives for processing at a refinery. These storage facilities called "tanker farms" have many huge storage tanks with rounded tops that will hold millions of barrels of petroleum.

Coal

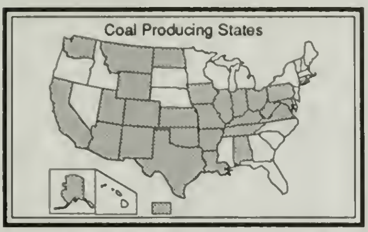
As mentioned before, coal can be brought out of the mine in small rail cars or on a conveyor belt (similar to ones used at grocery store checkout counters). After leaving the mine, it is carried by truck to be crushed into smaller pieces (these are easier to ship, clean, burn, etc.)



Pipeline
D&PP—Page 16
Supplement—Lesson 3

The crushed coal can then be sent by truck, railroad, barge, ship, or pipeline. Yes, it can be sent through a pipeline if it is mixed with oil or water. The mixture of finely crushed coal and oil or water is called a "slurry." Some of the coal mined in the U.S. is sold to foreign countries. This coal is sent overseas in huge ships.]

Student Activity Options:



Fossil Energy Producing States
(1 of 3 Examples)

D&PP—Page 12
Supplement—Lesson 3

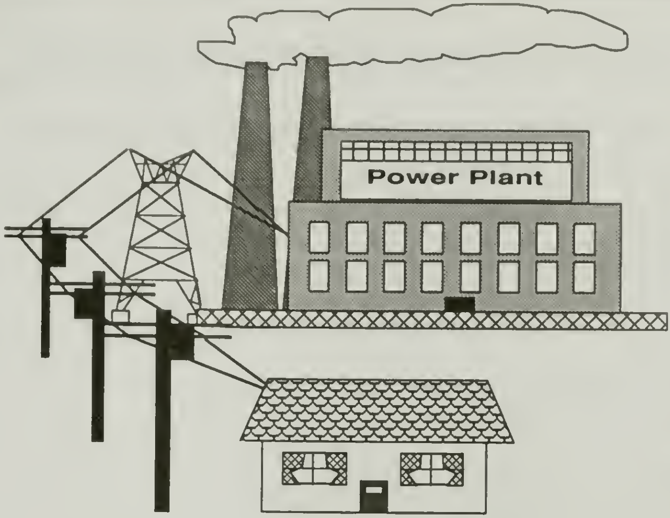
1. Discuss the three U.S. Fossil Fuel Production Maps on *D&PP*, page 12, or in the *Supplement*-Lesson 3.

> NOTE: These maps depict states that currently have recorded amounts of fossil fuels in production. Other states may have fossil fuel resources that are not in production. Check with the U.S. Geological Survey or the Department of Natural Resources of your State for data on actual deposits of fossil fuels in your area.

2. Answer the "Coal Quiz" located in the *Supplement*-Lesson 3.
3. Answer the "Transportation Quiz" from *D&PP*, page 16.

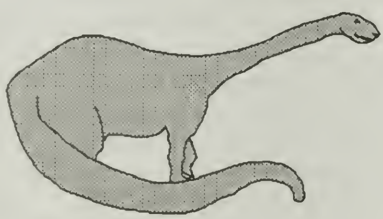
Student Follow-up or Extension Options:

1. Read *D&PP*, pages 8–10, for the next lesson: Fossil Fuels–Potential Environmental Problems and Solutions.
2. Write the U.S. Geological Survey or the local Department of Natural Resources (both usually located in your capital city) for information on what fossil fuels are located in your specific area (See "Things to Do," page 13, and "For More Information," page 15, in *D&PP*).
3. Cut out pictures of oil drilling rigs, coal mines or miners, layers of the Earth, trains, barges, ships, tanker trucks, etc. for the collage.
4. Ask a resource speaker from an oil, natural gas, or coal company to discuss detection and extraction of fossil fuels.
5. Ask a resource speaker who is employed as a coal miner or oil or natural gas driller to speak about their working experiences.
6. Ask a resource speaker from the local power company to discuss obtaining fossil fuels for generation of electricity.
7. Show a film or video tape on coal mining or oil and natural gas drilling (See "For More Information" in *D&PP*, page 15, for ideas where to obtain audio visuals).
8. Practice spelling words from the word list for this Lesson (found in the *Supplement*-Lesson 3) or write a definition for each word or word group.



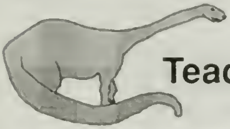
Teacher's Guide

Lesson Four

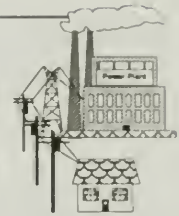


Fossil Fuels

Potential Environmental Problems and Solutions



Teacher's Lesson Plan & Activity Guide



Lesson 4: Fossil Fuels—Environmental Problems and Solutions

Key Questions:

What are the potential environmental problems that fossil fuels can cause? What answers have we developed to solve these problems? What is global warming?

Objectives:

Students should be able to:

1. Name one way to clean up an oil spill. *(D&PP page 8)*
2. Name one way to control air pollution from cars. *(D&PP page 8)*
3. Name at least one pollutant in coal. *(D&PP page 9)*
4. Name two types of sulfur. *(D&PP page 10)*
5. List four ways to make cleaner use of coal. *(D&PP pages 9 & 10)*

Time Allotment

One or two 30–45 minute lessons

Suggested Materials:

Dinosaurs and Power Plants ("D&PP"), pages 8–13
Two raisin or chocolate chip cookies for each student
D&PP Teacher's Guide Supplement ("Supplement"), Lesson 4

- Drawing-"Environment"
- Drawing-"Spaceship Earth"
- Drawing-"Early Natural Gas Lights"
- Drawing-"Natural Gas Pipelines...to the Moon"
- Drawing-"Air Pollution...Car Maintenance"
- Drawing-"Oil Spills Can Harm Wildlife"
- Drawing-"Oil Spill Containment"
- Drawing-"Improper Waste Disposal Can Pollute Steams"
- Drawing-"...Pollution Is Everyone's Responsibility"
- Drawing-"Making Coal Easier to Clean and Burn"
- Drawing-"Cleaner Use of Coal"
- Drawing-"Cleaning Coal: Coal Washing"
- Drawing-"Coal with Sulfur"
- Drawing-"Sulfur in Coal: Pyritic & Organic"
- Drawing-"Clean Coal: Limestone and Clean Coal"
- Drawing-"Coal Conversion"
- Word List
- "The Road to Clean Coal" Maze Puzzle
- Fossil Energy Word Puzzle

Dinosaurs and Power Plants

Introduction Method:

Purpose-

To acquaint the student with challenges associated with using the Earth in an environmentally responsible manner, today's Introduction will involve the concept of reclaiming the land after coal mining.

Activity-

1. Give each student one cookie and ask them to remove and eat all the raisins or chocolate chips. Tell the students to be sure to save all of the cookie except the raisins or chips.
2. After they have eaten the raisins or chips, tell them to rebuild the cookie from the pile that remains on their desks.
3. Ask them to share their experiences in rebuilding the cookie. List their difficulties on the chalkboard.

This activity allows us to see how difficult it is to put the land back as it was before coal mining occurred. Today's surface coal mining practices allow each mining company to restore the land after it is mined. Dirt is filled in and grass and trees are planted. However, years ago, we did not think of the future and we misused the land through practices such as strip mining where huge holes were cut in the ground as we mined for coal or other minerals. Once we got all the coal we could, we left gigantic holes in the Earth that eroded when it rained and were lifeless and unsightly.

Today, we think ahead before we mine the land to see how it can be restored for other uses, such as housing or farming, after the coal is mined. We no longer "strip" the land of its valuable resources and then leave it. We have developed improved surface mining and land reclamation methods.

This is similar to what happened to the cookie. We mined the raisins or chips from the cookie without thinking. Next time we will know that planning ahead is important in being able to restore the leftover cookie; we will also know that planning and careful thought is important in using our Earth in a responsible manner.

If the Lesson is split into two parts, steps 4 and 5 may be used as an Introduction on the second day.

4. Distribute a second cookie to each of the students and tell them to again remove the raisins or chips then restore or "reclaim" the leftover cookie.
5. List on the chalkboard what the students did differently that made the reconstruction of the cookie easier.

Environment

D&PP—Page 8
Supplement—Lesson 4

Key Question:

Why should we be concerned about how our use of fossil fuel resources affects the Earth?

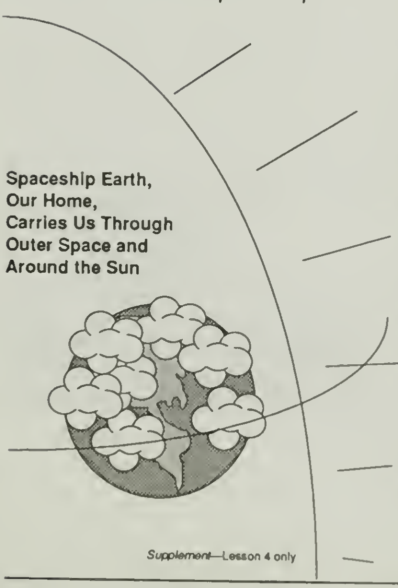
[and Answer]

[Our Earth is like a giant spaceship travelling through space. Years of planning and development occur long before astronauts can take off in a spaceship. The spaceship will be their home. It must protect and sustain the astronauts. There has to be air they can breathe; food they can eat; space for work as well as exercise, bathing, and sleep; effective waste disposal; etc. These things constitute their "environment." They are things the astronauts require to exist while on their journey through space.

Spaceship Earth

Our environment is what the plants and animals of our world need to live as we travel around the Sun on the Spaceship Earth.

We have to be concerned about anything that contaminates our air, water, or land as without these three things we would surely die. We have to be aware of past problems, today's problems, and tomorrow's potential problems. Just as an astronaut has to conserve and protect his resources of air, food, and the spaceship itself, so do we. We have only one Spaceship Earth. If we destroy the Earth, we will not survive.]



Let's discuss how our use of fossil fuels might affect Earth and our lives.

Supplement—Lesson 4 only

Dinosaurs and Power Plants

Key Question: **What potential environmental problems can <u>natural gas</u> cause? What answers have we developed to solve these problems?**

Early Use

[Burning of natural gas contributes the smallest amount to air pollution of all of the fossil fuels. It is also colorless and odorless. The odor you might smell for a <u>short time</u> in your home when you <u>first</u> turn on a burner on a stove that uses natural gas is due to a chemical added as a safety feature by the company offering the natural gas as a fuel. The chemical they add is called "mercaptan." It is used to cause an unpleasant odor that customers will notice in case of a natural gas leak.

Early Natural Gas Lights

D&PP—Page 2
Supplement—Lessons 2 & 4

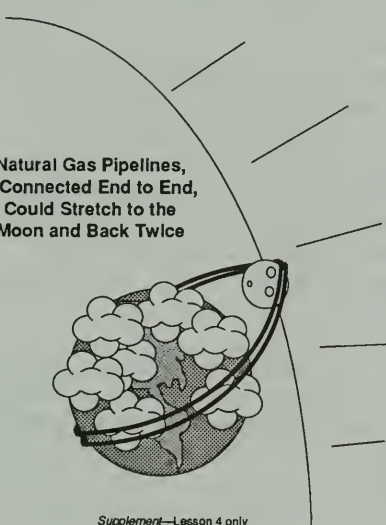
In the early days of natural gas use, the wooden pipes went only as far as the homes and businesses near the well. Even at this short distance, much gas was lost because the natural gas seeped out of the wooden pipes. Towns that had a natural gas well to furnish fuels for outdoor lighting many times let the lamps burn day and night because they had more of a supply of natural gas than they could use.

Drilling

Another early problem that has been solved by improved technology is the loss of natural gas when drilling for petroleum. As there was no distribution system for transporting natural gas to far away users, drillers exploring for petroleum did not welcome the discovery of natural gas. When a natural gas pocket was struck, they let the natural gas blow into the air and burn off in "flares" until the pressure was reduced enough to resume work on finding petroleum.

Today with modern equipment and drilling technology plus a vast pipeline system for distribution (a network of pipelines that, if connected end to end, would stretch to the moon and back twice) much of the natural gas that was lost is now saved for use in homes and factories.]

Natural Gas Pipelines, If Connected End to End, Could Stretch to the Moon and Back Twice



Supplement—Lesson 4 only

Dinosaurs and Power Plants

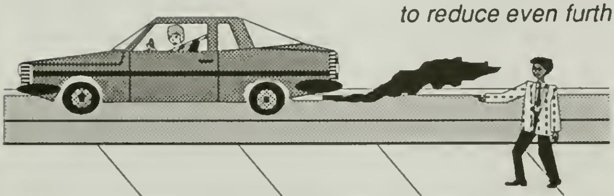
Key Question:

What potential environmental problems can petroleum cause? What answers have we developed to solve these problems?

[Petroleum and its products are continually studied so that they can be used in a increasingly environmentally safe manner. Petroleum was first used for the asphalt, tar, kerosene, grease, etc. that could be formed from it. After the automobile was invented, petroleum use skyrocketed due to increasing demand for gasoline.

Air Pollution

The United States has more vehicles per household that any nation in the world. Associated with that large number of cars, trucks, and vans is the problem of the air pollution those vehicles emit from their tailpipes. To reduce this problem, we have developed unleaded gasoline and catalytic converters. In some states, all vehicles must pass a test that analyzes the gases coming out of exhaust pipe before a license plate authorizing that vehicle to be on the road is issued. Considerable research is continuing on ways to reduce even further the air pollution from vehicles.



Air Pollution Can Be Reduced By Proper Car Maintenance

Supplement—Lesson 4 only

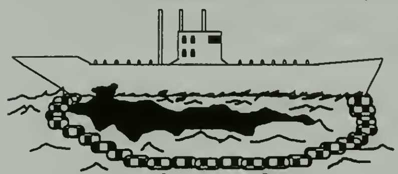
Oil Spills

Another potential problem is caused when petroleum or its products are spilled on bodies of water, such as rivers, lakes, or oceans. Oil floats on top of water and can cause serious harm to wildlife and the environment. Fish can die from lack of oxygen in oil covered waters. Other animals that swim in or depend on food from these waters can also die from exposure to the cold, ingestion of oil when cleaning themselves, or starvation when the food source they usually depend on from the water, such as fish or clams, dies. Our beaches also become oil coated. Harbors are closed. Fishermen cannot earn their living. Oil spills are serious and expensive to clean up. Research is continuing on improved equipment and technology for transporting petroleum and its products safely. There are also intensive studies being funded to find quicker and more effective ways to clean up spills when they do occur.

Oil Spills Can Harm Wildlife

Supplement—Lesson 4 only

What is Done After a Spill



A Floating Fence of "Booms" Can Keep Oil From Spreading on Water after a Spill

Supplement—Lesson 4 only

*The **first** thing that is done in case of an oil spill is to find the source of the spill and prevent more oil from escaping.*

*The **next step** is "containment" where "booms" or floating fences are put around the source of the spill to keep as much oil as possible from spreading. This has to be done very quickly as the oil can move rapidly across the water, particularly in rough seas. Then there are four ways that the oil can be cleaned up.*

Cleaning up the Oil

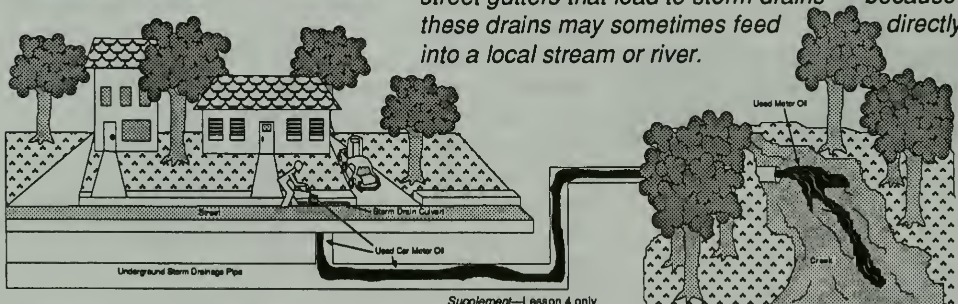
1. *The most common clean up method is by skimming or scooping up the oil.*
2. *Another method is absorption where materials are spread on the oil slick that can absorb and prevent further spread of the oil. This procedure is followed by skimming the absorbent with the oil off the water.*
3. *A third technique is chemical dispersal that involves spreading chemicals on the slick that cause the oil to break up into tiny droplets and sink to the bottom.*
4. *A fourth option is burning the oil off the surface of the water. Rags are set on fire and dropped from the air on the water to ignite the oil.*

There is also research being conducted on the use of oil-eating microscopic "bugs" or microbes. These naturally occurring microorganisms digest the oil and convert it into less harmful materials.

Waste Disposal

Waste petroleum products also can pose problems if not disposed of in an environmentally safe manner. Used lubricants (such as grease), waste oil (such as the used oil drained from the motor of the family car), antifreeze, or brake fluid should not be poured into street gutters that lead to storm drains because these drains may sometimes feed directly into a local stream or river.

Improper Waste Disposal Can Pollute Streams



Supplement—Lesson 4 only

The motor oil from one oil change in the family car can pollute one million gallons of water (enough water for 50 families for one year), if the oil is disposed of improperly.

Hazardous Problems

Even if the storm drains feed into the local water treatment plant, the used oil and the materials it has picked up from the vehicle can cause major problems for the clean up process at the treatment plant. Used motor oil can be particularly hazardous as it contains toxic metals such as lead. If incompatible chemicals, such as brake fluid and pool cleaner, get mixed after they are dumped into a drain, they could form a deadly gas, ignite, and explode.

Dumping petroleum waste products on land will also kill vegetation and pose a threat to wildlife as well as causing an environmental eyesore.

Safe Disposal

Each area of the United States has means of recycling or disposing of these wastes properly. You should contact your city or county waste disposal office for more information before disposing of these materials.]

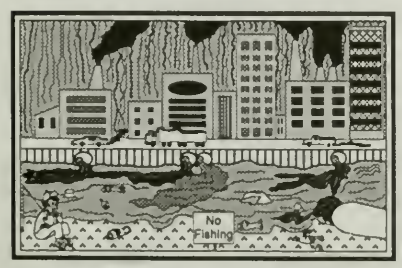
Key Question:

What potential environmental problems can coal cause? What answers have we developed to solve these problems?

If the Lesson is to be divided into two parts, begin the second session at this Key Question.

[As shown in the exercise at the beginning of this lesson, it takes careful planning to use the land in a responsible manner. Surface mining for coal is certainly a good example of this fact. Areas of the country still bear the marks of the poor mining practices of the past. However, mining companies today with thoughtful planning not only are able to obtain the coal, but are also able to restore the land to other useful purposes.

In the past, coal fueled the machinery that allowed the U.S. to become an industrial giant. Many homes also used coal for heating and cooking. But in those days little was known about cleaning pollutants from coal. When coal was burned it released the sulfur and other impurities trapped within it. Where coal was used in large amounts, the air was often full of soot and foul odors.



Preventing Pollution Is Everyone's Responsibility
Supplement—Lesson 4 only

Today, we are learning how to use coal in cleaner ways. Scientists have found ways to remove sulfur and other impurities from coal. They are teaching us how to burn coal without releasing the impurities and how to change coal into a clean burning gas or liquid before it is burned.

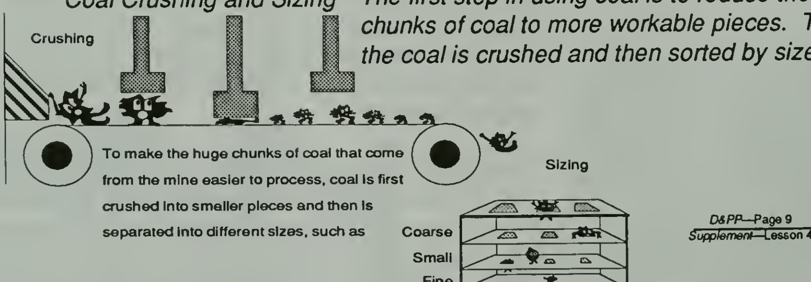
> Do you remember from the past lesson what fraction of the world's coal America has? *D&PP*— page 4.

The U.S. has more coal resources for generating electricity than it does other fossil energy resources. At this time, **coal is used to produce over half of the electricity in this country**. *In the future as our population increases and more people need electricity at home and at work, it may be increasingly important to be able to use our coal resources in an environmentally clean manner. If we are to use more coal to produce energy and other products, we must find ways to prevent two kinds of pollutants from being released to our air. One of the pollutants is* **sulfur** *and the other is a form of* **nitrogen**.

Sulfur pollutants can be reduced by finding ways to take sulfur our of the coal or to remove it from the smoke produced when coal is burned.

Nitrogen is a little different. When coal is burned some nitrogen is released from the coal. However, some nitrogen also comes from our atmosphere. Nitrogen is harmless in the air until it is heated to high temperatures. Then some of the nitrogen is changed into an undesirable gas (nitrogen oxide). Burning coal at low temperatures (1500 – 3000 degrees F) will keep nitrogen pollutants low.

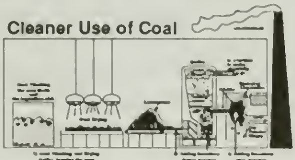
Coal Crushing and Sizing



The first step in using coal is to reduce the huge chunks of coal to more workable pieces. Therefore, the coal is crushed and then sorted by size.

After these steps, the coal begins the cleaning processes that will reduce any pollution that could harm us or our environment.

4 Ways for Cleaner Use of Coal

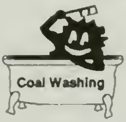


D&PP—Page 9 / Supplement—Lesson 4

There are 4 ways that we can make cleaner use of coal:

1. ***Cleaning** the coal **before** it is burned,*
2. ***cleaning during** coal burning,*
3. ***cleaning after** the coal is burned, and*
4. ***changing** coal **to a clean burning liquid or gas**.*

1) <u>Cleaning Before Burning</u>



D&PP—Page 10 / Supplement—Lesson 4

After coal is crushed and sized, it can be cleaned before it is burned. One method to do this is by washing.

The Structure of Coal

To understand how coal washing works, imagine the structure of coal as a pile of marbles. Most of the marbles would be carbon, a basic element found in all living things. The plants that lived millions of years ago and formed today's coal were composed of the this carbon so it is reasonable to find it as part of coal composition. But there are other substances in coal.

D&PP—Page 10 / Supplement—Lesson 4

Sulfur in Coal

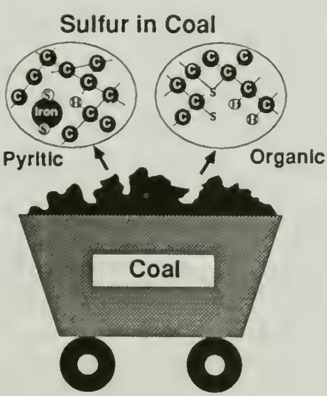
Some of the marbles are the sulfur we discussed earlier. Sulfur, in its pure form, is very useful. It is often used in medicines used by doctors to treat illnesses. In coal, sulfur is a problem. When coal burns the sulfur breaks loose and forms a foul smelling gas.

Acid Rain

In our air, sulfur gases can combine with water vapor (visible particles of moisture floating in the air) and form a weak acid that can fall to earth as "acid rain." Studies are being funded to determine what effect this "acid rain" has on vegetation (such as trees), on lakes, on wildlife, and on our health.

Two Kinds of Sulfur

*Sulfur in coal exists in two forms. Some of it is bound to the carbon and is know as **"organic"** sulfur. The rest of the sulfur is not connected to the carbon but is glued to other elements such as iron. The sulfur connected to iron is called **"pyritic"** sulfur.*



D&PP—Page 10 / Supplement—Lesson 4

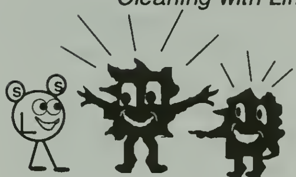
The distinction is important because different kinds of cleaning processes are needed to remove the two types of sulfur. Whereas much of <u>pyritic</u> sulfur can be removed by washing the coal, better methods are need to remove organic sulfur.

Some of the clean coal technologies that government and industry are studying may provide the extra cleaning required to remove <u>organic</u> sulfur.

If sulfur can be removed before the coal reaches the power plant to be used to generate electricity, utility companies would not have to install expensive cleaning devices onto the plant. Unfortunately, today's coal cleaning methods do no remove enough sulfur to meet air quality laws, so more sulfur must be removed at the power plant.

2) Cleaning During Burning

Cleaning with Limestone



Limestone and Clean Coal

D&PP—Page 10
Supplement—Lesson 4

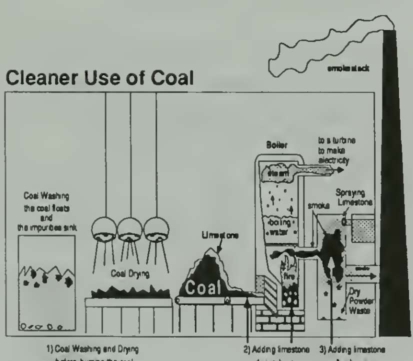
Coal can be cleaned at the power plant while it burns. In one advanced coal burner, called a fluidized bed combustor (burning is also called "combustion"), the coal is mixed with **limestone**. *This limestone acts as a sponge soaking up the sulfur as the coal burns. Since organic and pyritic sulfur are released during burning, both can be removed inside the combustor.*

More than 90% of the sulfur can be removed before the exhaust is released to the environment. The coal burns at a lower temperature so the formation of nitrogen pollutants is also reduced.

3) Cleaning After Burning

All types of coal produce at least a little smoke when they are burned. Most of the smoke is water vapor, but it can also contain sulfur and nitrogen if these pollutants have not been removed by coal washing before burning or by a removal procedure during burning. Many power plants use "scrubbers" after burning to remove sulfur pollutants before they release the smoke to our air.

Cleaner Use of Coal



D&PP—Page 9
Supplement—Lesson 4

Again limestone is used, but in a scrubber it is sprayed along with water into the smoke. Scrubbers are expensive (higher electricity bills to you and me), they do not remove nitrogen, and they produce a wet, pasty waste product call "sludge" that the utility company must find a way to dispose.

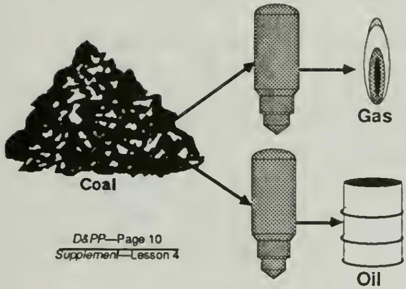
The clean coal technologies being developed will help overcome these drawbacks. One technology injects dry limestone into the ductwork (the pipes leading out of a boiler) rather than waiting for the smoke to reach the smokestack (pipe leading out of the plant through which smoke is emitted to the atmosphere).

The sulfur is removed as a dry powder rather than a wet sludge. The dry waste is much easier to dispose. In some cases, the dry powder can be used to make building materials or as a soil conditioner.

Another clean coal technology uses special chemicals called "catalysts" to change nitrogen oxide pollutants back into harmless nitrogen before they are released into the air.

4) <u>Coal Conversion</u>

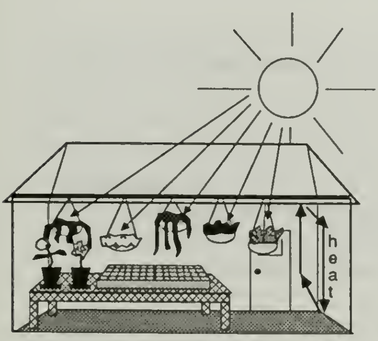
Coal can also be changed into a clean burning gas or a liquid fuel. The techniques involve heating and squeezing coal under high pressure until the coal breaks down into a gas or liquid. The processes that allow these conversions are called ***coal gasification*** *and* ***coal liquefaction.***



Changing coal to a gas or liquid has a number of advantages such as easier sulfur removal and easier handling and burning. Also, these gases and liquids can often be used in equipment originally designed to burn oil without making major changes to the current equipment thus saving the company (and the customers) money.

Key Question:

What is global warming? What causes it to occur? Why is global warming a concern? How can we reduce it?



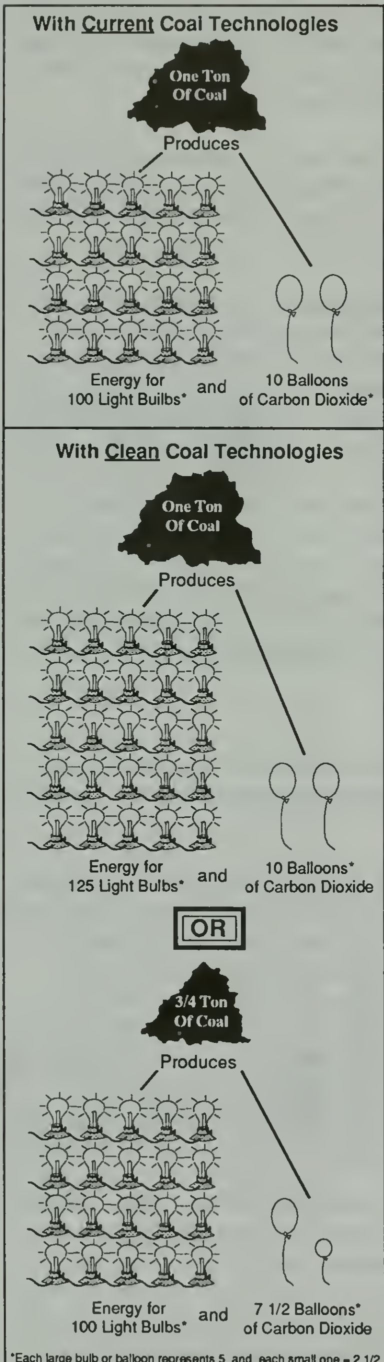
The Greenhouse Effect

The glass roof of a greenhouse allows the rays of the Sun to penetrate but does not let any heat escape. The climate in the greenhouse stays very warm and humid. Carbon dioxide and other gases in our atmosphere could have the same effect on Earth and cause the temperature to rise worldwide.

All fossil fuels release carbon dioxide when they burn. (People also exhale carbon dioxide when they breathe.) Much of this carbon dioxide is used by green plants during photosynthesis in order to produce oxygen (which we, in turn, need to inhale). Some carbon dioxide is even trapped in the oceans. But since the world's population began using more machinery and burning more fossil fuels, larger amounts of carbon dioxide have been released into the air than either plants or the oceans can capture.

In the air, carbon dioxide (and several other types of gases) act like the glass roof on a plant greenhouse. The gases let sunlight in and do not let heat out. Scientists are concerned that this "greenhouse effect" could make our planet warmer. Raising the temperature of Earth could have many consequences, such

Dinosaurs and Power Plants



as the loss of shoreline areas because the oceans rise as the ice caps of the North and South Poles melt, change of semi-arid land into desert, change of the areas where temperature sensitive crops can be grown, etc.

Many ways are being examined to reduce the release of carbon dioxide, but one of the best ways available now is to produce more energy while using the same amount of, or less, fuel (in other words, increase the efficiency of the energy process). Since coal releases more carbon dioxide then any other fossil fuel, most of the research has focused on the efficiency of coal use.

Many clean coal technologies achieve the higher efficiencies. Think of a typical coal-burning electric plant as consuming a single ton (2000 pounds) of coal every hour (actual plants consume several thousand tons of coal every hour). Let's say that from the ***one ton of coal,*** *we can produce enough* ***electricity to light 100 light bulbs****. But in addition to energy, the ton of coal produces enough* ***carbon dioxide to fill 10 balloons****.*

Suppose we replace the oil coal-burning technology in the plant ***with new clean coal technology****. As a result, the plant can now produce* ***enough electricity for 125 light bulbs*** *— not 100 — while* ***still burning a single ton of coal and releasing the same amount of carbon dioxide****.*

Or you can look at our power plant another way. Perhaps we only need enough ***electricity for 100 light bulbs*** *rather than 125. Instead of burning one ton of coal, we can* ***burn 3/4 of a ton*** *if we use new clean coal technologies. Because the same amount of electricity is produced with less fuel,* ***only 7 1/2 balloons of carbon dioxide are produced.*** ***The same amount of energy is made but with less carbon dioxide released into the air.***

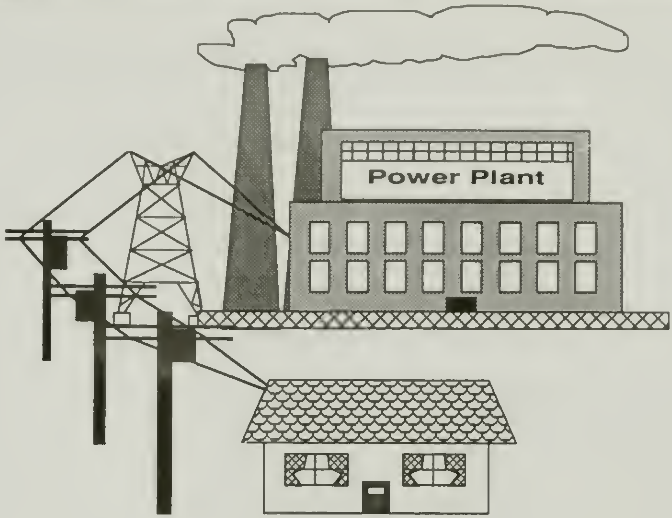
Until better ways are found to prevent carbon dioxide from being released into the atmosphere from fossil fuel burning plants, using less energy and increasing plant efficiency are the most practical ways to avoid problems from the "greenhouse effect," such as global warming.

Student Activity Options:

1. Complete "The Road to Clean Coal" Maze, *in D&PP*, page 11, or in the Supplement-Lesson 4.
2. Answer the "Fossil Energy Puzzle," *in D&PP*, page 13, or in the Supplement-Lesson 4.

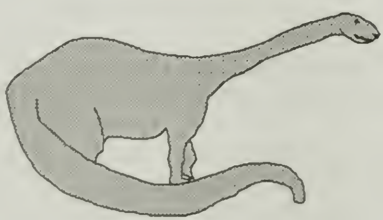
Student Follow-up or Extension Options:

1. Read *D&PP*, page 12, for next the lesson on Fossil Fuels–Energy for the Future.
2. Draw a scene that shows problems caused by pollution. Then draw how we can prevent or clean up pollution.
3. Cut out pictures about environmental problems caused by fossil fuels and pictures of how clean the environment will look as we use fossil fuels in cleaner ways. (Have clippings ready to finish collage on last day.)
4. Have a resource speaker from the Environmental Protection or Pollution Control Agency in your State discuss what fossil fuels are used in your area, how fossil fuels influence environmental problems, and what is being done to clean up past problems (e.g., strip mining) and prevent future problems (e.g., air pollution).
5. Practice spelling words from the word list for this lesson or write a definition for each word or word group.
6. Report on educational or news programs you see on television about the environment.
7. Start a recycling program at your school.
8. Find out and report to the class what plans your city or county has to keep the air, water, and land clean.
9. Watch films on the environment (especially those concerning showing new concepts in using fossil fuels in more environmentally safe ways).



Teacher's Guide

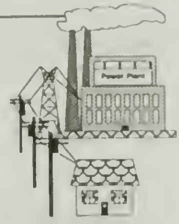
Lesson Five



Fossil Fuels

Energy for the Future

Teacher's Lesson Plan & Activity Guide



Lesson 5: Fossil Fuels—Energy for the Future

Key Questions:

What will our energy needs be in the future? How will we meet these needs? What are we doing to assure a secure energy future for our nation?

Objectives:

Students should be able to:

1. Complete this sentence. "As fossil energy resources are ____________, population and industrial needs are _____________ in the U.S. and the world." *(D&PP page 12)*
2. Name two things that the U.S. will need as a result of population growth. *(D&PP page 12)*
3. Name the resource used to produce electricity that is most abundant in the U.S. *(D&PP pages 2, 4, & 12)*
4. Name two ways we can save fossil fuel resources. *(D&PP page 12)*
5. Name the programs funded by the federal government that are developing methods 1) to use coal in cleaner ways and 2) to improve recovery of crude oil and natural gas. *(D&PP page12)*

Time Allotment:

30–45 minutes

Suggested Materials

Dinosaurs and Power Plants ("D&PP"), pages 12–15
D&PP Teacher's Guide Supplement (*"Supplement"*), Lesson 5
- Drawing-"Our Increasing Population"
- Drawing-"More Power Plants..."
- Drawing-"Ways to Assure a Secure Energy Future"
- Drawing-"Be a Discoverer...Explore Your World"
- Drawing-"Be An Intelligent Shopper"
- Drawing-"Voting Booth"
- Drawing-"Our World Depends on...Technology"
- Word List
- Copy of the Summary Quiz for Each Student
- Fossil Energy Feud/Super Feud
- Energy Spin

Supplement Lessons 1-5: Word Lists
Classroom Map of the World
Collage Activity Materials

Introduction Method:

Purpose-

To challenge the student to put knowledge gained from these lessons into action.

Preparation-

1. If the "Fossil Energy Feud/Super Feud" games are to be played, follow the instructions for preparation found with the game board in the *Teacher's Guide Supplement*–Lesson 5.

2. If "Energy Spin" found the the *Supplement*-Lesson 5 will be played, follow the instructions with the game.

3. If a Spelling Bee or "Word Power Challenge" is to be used as an introduction, compile a list of words that will challenge the class. Words can be taken from the word list found with each Lesson Plan in the *Supplement,* from the "Fossil Energy Glossary" (*D&PP*, page 14), or throughout the text of *D&PP.*

Activity-

Play Fossil Energy Feud/Super Feud or Energy Spin or conduct a Spelling Bee or Word Power Challenge (see Student Activity Options at the end of this Lesson Plan).

Then follow with the discussion questions in this last lesson for a look at our energy future, at the role fossil fuels may play, and the reasons that education of today's youth will be critical to every person in the United States.

Dinosaurs and Power Plants

Key Question: **Will our energy needs change in the future?**

[and Answer] *[Fossil energy resources are shrinking as population and industrial needs are growing. More people are living longer and more children are born every minute. For each person, there is a related increase in the need for building materials for homes and offices, energy for lighting and power equipment, ways to grow more food on less land, etc. Many, if not most, of these things depend on fossil fuels in some way.]*

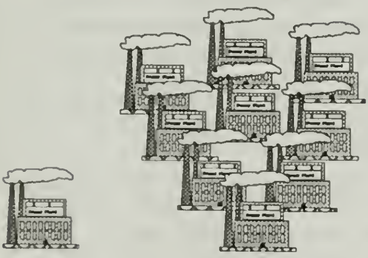
Key Question: **How will we meet these needs?**

[We will likely need to build more new U.S. power plants for electricity generation in the next 10 to 15 years than all the ones that presently exist in countries such as Japan and Germany.

Some of these plants could use solar or nuclear power, but coal is abundant and affordable. Properly cleaned, it could be used to satisfy much of our future demand for electricity and other fuel needs. Natural gas is also readily available and likely will be used in greater amounts in power plants.

The U.S. supply of petroleum, however, probably will continue to decline faster than we can find new oil fields. Better technology will get more crude oil out of the fields we have already found, but it will not be enough to satisfy our future demand for oil. Therefore, it becomes even more important to use petroleum wisely (e.g., recycling plastics and used oil) and to find new fuels that someday can substitute for the crude oil we use today (e.g., liquids produced by coal liquefaction).

More Power Plants Will be Needed to Produce Energy

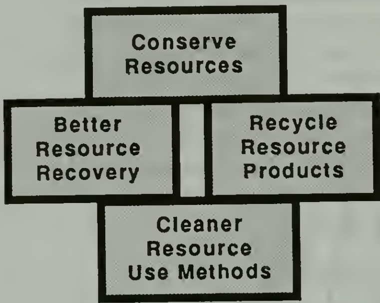


As the population increases, more power plants will need to be built to produce the energy required by new jobs and homes

Dinosaurs and Power Plants

Key Question: **What are we doing to assure a secure energy future in the United States?**

Ways To Assure A Secure Energy Future



[We can all help ensure a secure energy future by helping to not waste our fossil energy resources. We can save fossil energy by turning off lights and electricity using machines, such as radios and televisions, when we leave and go on to another activity or room. We can walk or ride our bikes on short distance errands. We can recycle products made with fossil fuel resources.

We must also continue our research into new ways of obtaining all of our resources in an effective, less costly manner. We must use our more abundant resources in every way that is safely feasible. The clean coal technology and the enhanced oil and gas recovery research programs are two ways the federal government is working to provide new options to Americans for a secure energy future.

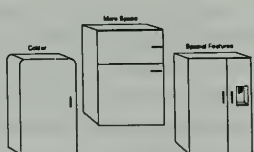
Be A Discoverer

Explore Your World

Young Americans *can help by finishing their education and continuing their interest in science and math. Each day you learn how something works or delve into something you have not studied before,* ***you are discoverers. You are scientists.***

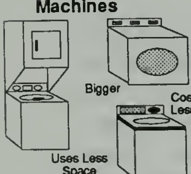
In the years to come, America will need to make critical decisions concerning energy options for its future. America will need citizens who understand why one option would be better for the Nation than another. You will need to be a ***wise energy consumer*** *and an* ***educated voter*** *to help your country evaluate these costly and important options.*

You will need to be aware of why your area needs a new power plant; why increased usage (caused by more people and jobs) will cause higher utility bills; why it's important to know how to use less heat, air conditioning, and electricity; what type of heating and air conditioning you want in your home (natural gas for heat and electricity for air conditioning?); how improvements in the ways we use energy related fuels will assist in protecting our environment, etc.



Refrigerators

Washing Machines



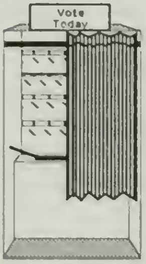
Studying science can help you understand how things work and make you a more intelligent shopper and energy consumer.

Automobiles

Be An Intelligent Shopper

Dinosaurs and Power Plants

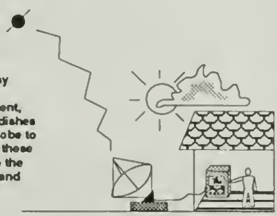
Our Country Relies on Its Voters



Elected officials and voters must be able to understand the problems and potential solutions in order to make the decisions that will keep the United States strong and healthy. Will YOU be ready when it is your turn?

Voting Booth

Even our everyday lives depend on technical equipment, such as satellite dishes for televisions. Jobs to install and repair these machines require the ability to understand new technology.



Our World Depends On Complex Technology

> SUGGESTION: Cut out magazine photographs of people representing various professions to display on the bulletin board. Think of some way that each person uses math or science in his/her work.

You will need to comprehend the issues behind our problems if you want to able to be one of our elected representatives who are faced with these challenges. You will also be responsible when you step into the voting booth to choose leaders who are knowledgeable about critical issues. You will have to understand what their proposals will mean to you and your family, community, country, and world.

By studying science and math now, you will have a strong base of understanding to apply in making these decisions.

As our society increasingly becomes more technical in the future ***(in the early 1950s there were few televisions — now think how we depend on technical machines, such as computers, VCRs, telephones, and satellites)****, the problems and solutions will become more technical.*

America is also going to need its young people to continue their studies in science and math and so that our Nation will have the scientists and technicians it needs to have a secure future. Many people in careers that depend heavily on science and math are and will be retiring in the next 10 to 20 years. The United States will need the young people of today to fill the jobs these people will be leaving. Some of these careers are: engineers, electricians, surveyors, biologists, geologists, computer specialists, draftsmen, carpenters, physicists, marine biologists, nurses, pipe fitters, etc. Our manufacturing processes that create such products as baseball bats are also highly technical.

Whether the work requires the ability to give correct change to a customer, to figure the amount of pipe needed for a job, to adjust the amount of chemicals needed at the local sewage treatment plant, or to load the correct amount of rocket fuel needed to reach a far planet, some science or math is necessary

America needs the students of today to get a good education so that the United States will continue to be a strong leader tomorrow.

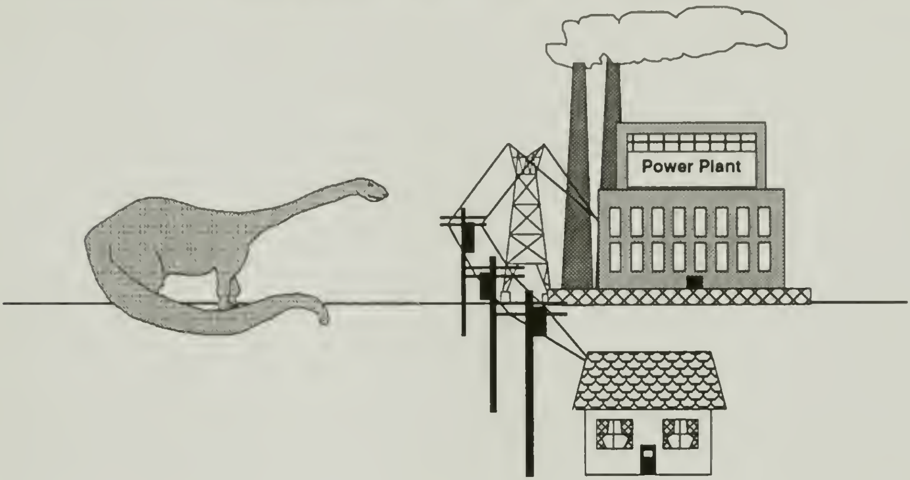
America is depending on YOU!]

Student Activity Options:

1. Hold a Spelling Bee using words in *D&PP* (start with words in "Fossil Energy Word Puzzle," page 13, and "Glossary," page 14, then go to word lists found in each lesson section of the *Supplement*).
2. Have a verbal "Word Power Challenge" to see how many students can correctly define the words that have been used during the lesson series. (See the "Glossary" in *D&PP*, page 14, or the word list in each lesson section of the *Supplement*).
3. Complete a quiz on the lesson series (see the short quiz in *D&PP*, page 15, or the quiz in the *Supplement*-Lesson 5 that was developed from the objectives listed for each lesson plan).
4. Play the "Fossil Energy Feud/Super Feud" games found in the *Supplement*-Lesson 5.
5. Play the "Energy Spin" game found in the *Supplement*-Lesson 5.

Student Follow-up or Extension Options:

1. Paste pictures collected for the collage into a representation of the creation, extraction, usage, etc. of fossil fuels and write a one page paper on why those pictures were chosen (display the collages then have some students read their papers to the class) .
2. Have students give reports developed from information they have obtained on fossil fuels.
3. Have a resource speaker from the Energy Office of your State discuss energy production and conservation in your area.



This series of classroom publications was produced by the Office of Fossil Energy of the U.S. Department of Energy. If you have questions or need addtional materials, please contact:

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